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DECEMBER, 1918
Volume 25 Number 4

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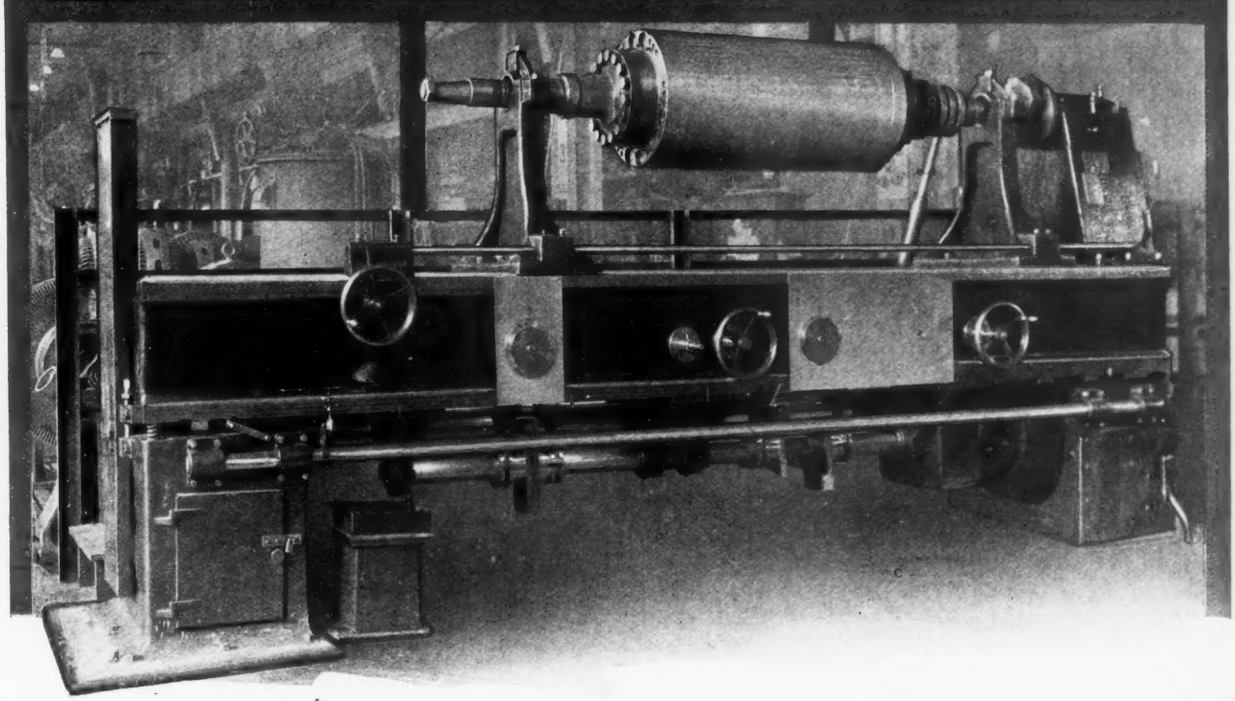
DECEMBER MACHINERY 1918

Dynamic and Static Balancing



First of Two Articles Explaining the Requirements that must be Fulfilled in Order to bring a Rotating Member into Dynamic and Static Balance and Describing Practical Shop Methods for Conducting the Work

BY EDWARD K. HAMMOND, Associate Editor of MACHINERY

IN order for a rotating member of a machine to run without vibration and to avoid unnecessary wear of the bearings, it is important for it to be brought into an accurate condition of dynamic balance. This is particularly true in the case of any member which runs at high rotative speed. Failure to obtain accurate dynamic balance will often develop vibration of such magnitude that it spreads from the rotating member to the entire machine, and is likely to cause trouble for various reasons. A case in point is seen in the operation of an abrasive wheel on a grinding machine where such vibration would result in the production of chatter marks on the work and thus seriously impair the accuracy of dimensions and the perfection of the finish produced. Similarly, lack of balance in an engine flywheel will often induce sufficient vibration to make all members of the engine extremely noisy and otherwise unsatisfactory in operation. In addition to troubles resulting from vibration developed through lack of dynamic balance, there is another undesirable condition produced, namely, an unbalanced rotating member tends to change its axis of rotation from the center line of the journals to an axis passing through the center of gravity of the rotating member; and this tendency for the shaft to be sprung out of line imposes excessive pressures and strains on certain sections of the bearings.

With the view of overcoming troubles resulting from a lack of dynamic balance, builders of such equipments as grinding machines, airplane and automobile engines, steam turbines, cream separators, electric motors, and many other types of high-speed machines have given a great deal of thought to the development of ways and means for securing an accurate condition of dynamic balance for the rotating members. One reason why the satisfactory application of accurate methods of dynamic balancing has been difficult for the shop man has been due to the lack of published information concerning the actual methods of procedure in handling this particular shop operation. Books on dynamic balance and articles discussing this subject, which have appeared in the technical press, have generally gone into detail concerning theory and unfortunately this requires quite an exhaustive mathematical treatment to reach the desired conclusions. It is a matter of fact, however, that where the proper equipment is provided for the purpose, shop men having no knowledge of the theory of dynamic balance and an insufficient training in mathematics to enable them to read highly technical articles and books on this subject, are quite able to bring machine members into accurate balance through the use of several different types of shop equipment that have been developed to meet the requirements of this work. It is the purpose of the present article to explain the features of these balancing machines,

and to show just how they are used to enable unskilled operators to bring machine members rapidly into dynamic balance.

Conditions which must be Fulfilled in Balancing Machine Members

It is a matter of quite general knowledge that a machine member is said to be in static balance when it may be mounted on an arbor supported on knife-edges or in any other convenient manner, and turned to any desired position, while supported in this way, without tendency for one side of the piece to seek a position at the bottom owing to its greater weight. A piece may be brought into static balance by simply removing metal from the heavy side. Static balance has no definite relation to dynamic balance; in other words, a machine member may be in perfectly accurate static balance and still be far out of dynamic balance. In order to satisfy the conditions of dynamic balance, a piece must be capable of rotating at high speed without tendency to vibrate and without changing the position of its axis of rotation from a line through the bearing centers to a line through the center of gravity of the rotating member. As previously stated, a piece may be in perfect static balance and yet be far from a condition of accurate dynamic balance; but whenever a condition of dynamic balance is obtained, the piece will also be in accurate static balance. In some cases, it is sufficient to bring the member into a condition of static balance, but in the case of high-speed machinery all rotating parts must be in accurate dynamic balance in order to avoid the objectionable conditions of operation to which reference has been made. When a machine member has been brought into accurate dynamic balance for any one speed it is also balanced for all other speeds.

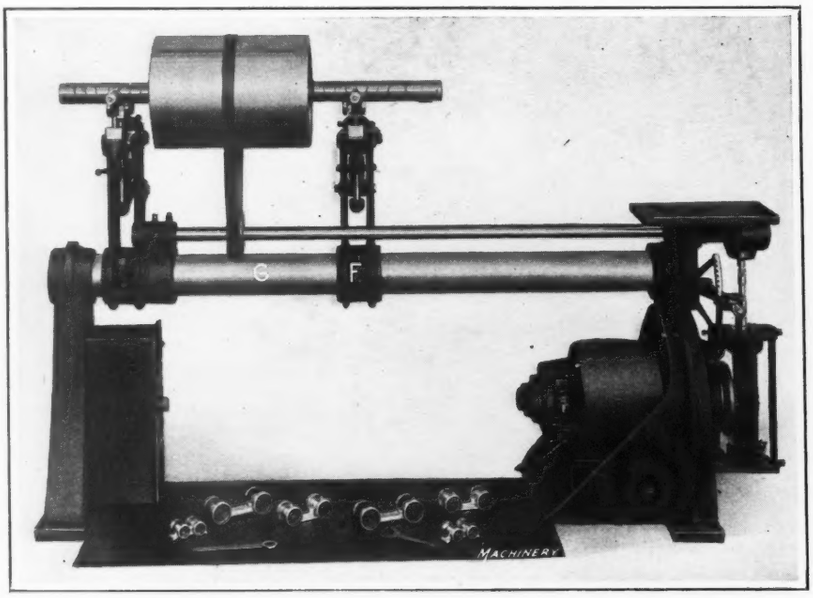


Fig. 1. Machine built by Norton Grinding Co. for indicating Unbalanced Points on High-speed Members of Grinding Machines, Preparatory to making Corrections for Lack of Dynamic Balance

Inaccuracy of either static or dynamic balance is due to lack of uniformity in the distribution of material about the axis around which the machine member rotates. It must not be inferred from this, however, that true symmetry of shape is a reliable indication of either accurate static or dynamic balance. Experience has shown that a symmetrical shaped piece is much more likely to be in static than in dynamic balance. The reason a symmetrical shape is no proof of perfect balance is because the material may not be homogeneous in structure. For instance, a flywheel of perfectly symmetrical form may have metal of different densities in different sections or there may be blow-holes at certain points in the metal which result in throwing too much weight at points diametrically opposite. Such a condition would destroy both static and dynamic balance. So far as dynamic balance is concerned, trouble is more likely to be experienced in the case of a long piece than in the case of a piece of moderate size. This is due to the fact that failure to obtain a proper condition of dynamic balance is caused by a torque induced through the presence of a heavy spot near one end of the piece and a corresponding heavy point near the opposite end, with these two points on opposite sides of the axis of rotation. Under such conditions, centrifugal force acting on these heavy points sets up a couple which causes the rotating member to vibrate and also springs it out of line with the bearings, thus setting up the undesirable conditions to which reference has been made. The condition is likely to be most severe in the case of long pieces, because the lever arm between the points of unbalance will be longer. Correction for lack of dynamic balance is made by applying weights at opposite ends of the work in such positions that they will offset the effect of the torque to which reference has just been made.

Norton Dynamic Balance Indicating Machine

To meet its own requirements in bringing the high-speed members of grinding machines into accurate running balance the Norton Grinding Co., Worcester, Mass., developed a dynamic balance indicating machine which is shown in Fig. 1. It is the function of this machine to provide means of supporting and rotating the member to be balanced under such conditions that the light side at each end of the member may be marked; then it is an easy matter to make the necessary correction in running balance by either adding weight on the light side or by removing metal by drilling or grinding from the heavy side. Fig. 1 shows the machine engaged in balancing a drum type of pulley for a grinding machine. It will be seen that the shaft on which this drum is carried is supported by friction reducing bearings and that the drum is rotated by means of a belt. Power is furnished by an electric motor which transmits motion through a friction disk on which the position of the roller may be adjusted to provide for rotating the pulley at any required speed. Provision is also made for reversing the direction of rotation. From the friction disk motion is carried up to the horizontal shaft which carries the pulley from which the belt transmits power to the drum. Attention is also called to the fact that provision is made for adjusting the machine for balancing pieces of different lengths by regulating the positions of uprights *F* on horizontal bar *G* by which they are supported.

After the pulley has been set up on the dynamic balancing machine, the first step is to apply a light coat of red lead or Prussian blue to the portion of the supporting shaft at each side of the drum which is directly in line with the sharp point of a scriber. As the drum rotates, lack of dynamic balance will tend to set up vibration and the operator carefully advances each of the scribers toward the shaft until a position is reached where the point of each scriber just leaves a mark in the Prussian blue. This mark will not extend all the way around the shaft. After a mark has been made by each scriber, the direction of rotation of the drum is reversed and the scribers are moved laterally to provide for making a second mark about 1/16 inch from each of the marks made with the drum rotating in its initial direction. This method of marking has been applied in a number of different types of dynamic balancing machines, some of which are described in later sections of this article. In

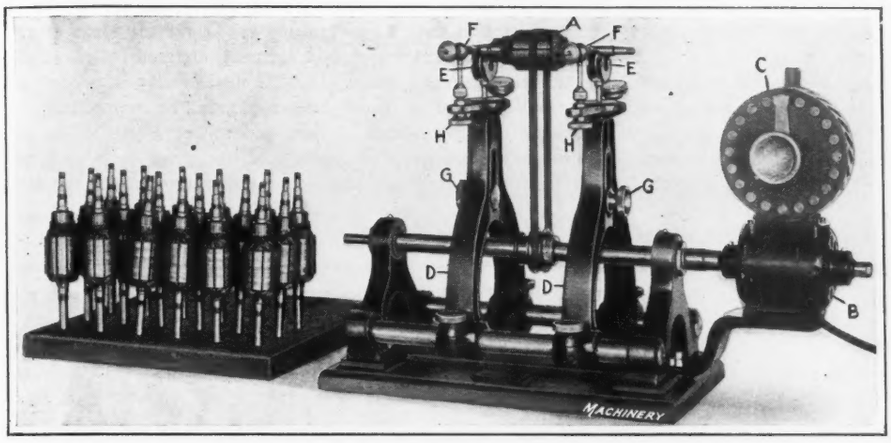


Fig. 2. Machine used by Wisconsin Electric Co. for bringing High-speed Electric Motor Armatures into Accurate Dynamic Balance

order to provide for the vibration of the drum, the bearings by which the drum shaft is carried are supported on inverted pendulums. At their upper ends these pendulums pass through holes cut in rubber bumpers so that they can swing a short distance as the drum and its shaft vibrate, but this vibration cannot exceed certain well-defined limits. With this arrangement the required degree of sensitiveness is obtained.

It is particularly important to note that in starting at low speed and steadily increasing the rate of rotation of the member which is to be balanced, the vibration will increase steadily up to some speed, the exact value of which is determined by the condition of balance in which the machine member under test happens to be. When this "critical" speed is reached, all vibration will cease, and the speed may be increased until the critical range of speed is passed, after which vibration will once more commence. It should be noted that for speeds below the critical range the marks made by the scribers will be located on the heavy side of the work, while above the critical speed range the marks will be on the light side. As the critical speed range is usually quite low, the general practice is to drive the member under test at a speed above the critical range, so that the marks are made on the light side. But although the mark may be produced on either the heavy or the light side according to the speed, it is not located exactly at the heavy or light spot but is displaced from the true position in a direction which depends upon the direction of rotation of the body; that is to say, this displacement will be in one direction when the member is revolving to the right, and an equal amount in the opposite direction when the member is revolving to the left. When marking on the heavy side the marks lag behind and when marking on the light side they are in front of the exact spot it is desired to locate.

One simple way of definitely determining whether the marks are on the heavy or light side is to place arrow heads at the centers of the marks indicating the direction of rotation in which each mark was made. If these arrow heads point toward each other they show that the mark is on the heavy side, while if they point away from each other they show that it is on the light side. Consequently, the arrows always point toward the heavy side of the work. The method of procedure is then to locate the point midway between the centers of the two marks in order to determine the light side or the heavy side, as the case may be.

After this has been done, it is an easy matter to make the required correction in balance by either adding weight at the light side or removing weight from the heavy side. After this correction has been made, the work is put back on the machine and again tested, this procedure being repeated until it is found that the necessary correction has been made so that the dynamic balance indicating machine does not show any error at either end of the piece which is under test. After some experience, the operator of the machine will learn to judge the amount of stock that it is necessary to remove or add by the length of marks produced by the indicators, and he will generally be able to produce an accurate condition of balance after two or three attempts. As the greater part of the time is taken in balancing and not in the work of applying marks on the indicating machine, the balancing department in the plant should have the indicating machine and the drilling or grinding machine located close together, in order to facilitate handling the work as far as possible.

In balancing a grinding machine pulley on the Norton dynamic balancing machine, the lines are scribed in the manner already described, and the central point is located at which these scribed lines overlap each other with the pulley running in opposite directions. Owing to "lead" between the rotary motion of the pulley and its vibratory motion, this overlapping of the scribed lines represents the light side of the pulley, although a casual consideration of the matter would doubtless lead one to believe that this marked the heavy side. When the light side has been located, a hole is drilled and counterbored, so that a lead weight of suitable size may be riveted onto the inside of the rim of the pulley at this point. To determine the amount of lead which must be added, a test weight is secured on the inside of the rim at the light point by means of a little putty. This putty, with the assistance of centrifugal force, holds the weight in the desired position while a test is being made to see whether this weight corrects the lack of balance. The size of the weight is then reduced slightly or increased, as the case may be, until the exact weight required to correct the lack of balance has been determined. A weight of this size is then

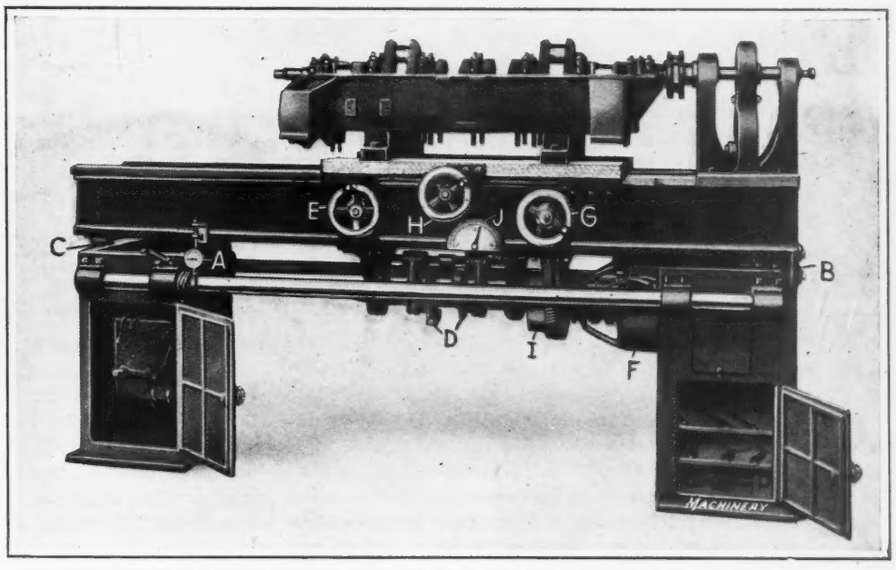
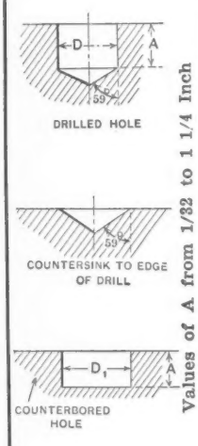


Fig. 3. "Carwen" Dynamic Balancing Machine built by the Carlson-Wenstrom Co.

secured to the inside of the rim of the pulley by means of a rivet. After the principal error in balance has been corrected through the addition of a weight, it will quite often be found that there is some minor lack of balance which was effectively masked by the greater error which has now been located and corrected. In such cases, it is necessary to add a second weight at the proper point on the pulley in order to overcome the lack of balance and bring it into such a condition that there will be no tendency to vibrate while rotating at high speed.

factory manager of the firm. When this machine was placed in operation it gave a remarkably good account of itself and removed any doubt which had formerly existed in the minds of the management concerning the desirability of taking up the manufacture of these internal grinding machines. In working out the design, it was considered desirable to use die-castings for the two halves of the case in which the driving motor is contained, and a contract was let for 5000 sets of these castings. The first start in producing "Dumore" grinding machines on a manufacturing basis was to put through a lot of fifty, and when the first of these were completed and ready for operation, it was found that a most remarkable difference existed between the operation of the first, or what might be called the experimental machine, and those which had been produced on a manufacturing basis. While the first machine had run very smoothly and produced

WEIGHTS OF STEEL IN OUNCES REMOVED BY DRILLING OR COUNTERBORING[1]



Values of A from 1/32 to 1 1/4 Inch

	Diameter of Drills = D Inches									
	1/8	3/16	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/16
Weight of Countersink, Ounces	0.00068	0.0023	0.006	0.019	0.044	0.086	0.149	0.225	0.368	0.457
1/32	0.00243	0.0062	0.0129	0.0346	0.0718	0.1294	0.212	0.310	0.478	0.582
1/16	0.00418	0.0101	0.0199	0.0503	0.0996	0.1728	0.275	0.395	0.588	0.707
3/32	0.00593	0.0140	0.0268	0.0659	0.1274	0.2162	0.337	0.480	0.698	0.832
1/8	0.00768	0.0179	0.0338	0.0816	0.1552	0.2596	0.400	0.565	0.808	0.957
5/32	0.00943	0.0218	0.0407	0.0972	0.1830	0.3030	0.462	0.650	0.918	1.082
3/16	0.01118	0.0257	0.0477	0.1129	0.2108	0.3464	0.525	0.735	1.028	1.207
7/32	0.01293	0.0296	0.0546	0.1285	0.2386	0.3898	0.587	0.820	1.138	1.332
1/4	0.01468	0.0335	0.0616	0.1442	0.2664	0.4332	0.650	0.905	1.248	1.457
9/32	0.01643	0.0374	0.0685	0.1598	0.2942	0.4766	0.712	0.990	1.358	1.582
5/16	0.01818	0.0413	0.0755	0.1755	0.3220	0.5200	0.775	1.075	1.468	1.707
11/32	0.01993	0.0452	0.0824	0.1911	0.3498	0.5634	0.837	1.160	1.578	1.832
3/8	0.02168	0.0491	0.0894	0.2068	0.3776	0.6068	0.900	1.245	1.688	1.957
13/32	0.02343	0.0530	0.0963	0.2224	0.4054	0.6502	0.962	1.330	1.798	2.082
7/16	0.02518	0.0569	0.1033	0.2381	0.4332	0.6936	1.025	1.415	1.908	2.207
15/32	0.02693	0.0608	0.1102	0.2537	0.4610	0.7370	1.087	1.500	2.018	2.332
1/2	0.02868	0.0647	0.1172	0.2694	0.4888	0.7804	1.150	1.585	2.128	2.457
17/32	0.03043	0.0686	0.1241	0.2850	0.5166	0.8238	1.212	1.670	2.238	2.582
9/16	0.03218	0.0725	0.1311	0.3007	0.5444	0.8672	1.275	1.755	2.348	2.707
19/32	0.03393	0.0764	0.1380	0.3163	0.5722	0.9106	1.337	1.840	2.458	2.832
5/8	0.03568	0.0803	0.1450	0.3320	0.6000	0.9540	1.400	1.925	2.568	2.957
21/32	0.03743	0.0842	0.1519	0.3476	0.6278	0.9974	1.462	2.010	2.678	3.082
11/16	0.03918	0.0881	0.1589	0.3633	0.6556	1.0408	1.525	2.095	2.788	3.207
23/32	0.04093	0.0920	0.1658	0.3789	0.6834	1.0842	1.587	2.180	2.898	3.332
3/4	0.04268	0.0959	0.1728	0.3946	0.7112	1.1276	1.650	2.265	3.008	3.457
13/16	0.04618	0.1037	0.1857	0.4259	0.7668	1.2144	1.775	2.435	3.228	3.707
7/8	0.04968	0.1115	0.1976	0.4572	0.8224	1.3012	1.900	2.605	3.448	3.957
15/16	0.05318	0.1193	0.2105	0.4885	0.8780	1.3880	2.025	2.775	3.668	4.207
1	0.05668	0.1271	0.2234	0.5198	0.9336	1.4748	2.150	2.945	3.888	4.457
1 1/16	0.06018	0.1349	0.2336	0.5511	0.9892	1.5616	2.275	3.115	4.108	4.707
1 1/8	0.06368	0.1427	0.2492	0.5824	1.0448	1.6484	2.400	3.285	4.328	4.957
1 3/16	0.06718	0.1505	0.2621	0.6137	1.1004	1.7352	2.525	3.455	4.548	5.207
1 1/4	0.07068	0.1583	0.2750	0.6450	1.1560	1.8220	2.650	3.625	4.768	5.457

	Diameter of Counterbores = D_1 Inches												
	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
1/32	0.007	0.0109	0.0156	0.0213	0.0278	0.0434	0.0625	0.085	0.1112	0.1408	0.1739	0.2104	0.250
1/16	0.014	0.0217	0.0312	0.0426	0.0556	0.0868	0.1250	0.170	0.2225	0.2816	0.3477	0.4200	0.500
3/32	0.021	0.0326	0.0468	0.0639	0.0834	0.3030	0.1875	0.255	0.3337	0.4224	0.5216	0.6300	0.750
1/8	0.028	0.0434	0.0624	0.0852	0.1112	0.1740	0.2500	0.340	0.4450	0.5632	0.6950	0.8400	1.000
5/32	0.035	0.0542	0.0780	0.1065	0.1390	0.2170	0.3125	0.425	0.5562	0.7040	0.8688	1.0500	1.250
3/16	0.042	0.0650	0.0937	0.1278	0.1668	0.2600	0.3750	0.510	0.6675	0.8448	1.0400	1.2600	1.500
7/32	0.049	0.0758	0.1093	0.1491	0.1946	0.3040	0.4375	0.595	0.7787	0.9856	1.2160	1.4700	1.750
1/4	0.056	0.0866	0.1250	0.1704	0.2224	0.3480	0.5000	0.681	0.8900	1.1260	1.3900	1.6800	2.000
9/32	0.063	0.0978	0.1406	0.1917	0.2500	0.3910	0.5625	0.760	1.0012	1.2640	1.5600	1.8900	2.250
5/16	0.070	0.1087	0.1562	0.2130	0.2780	0.4340	0.6250	0.845	1.1125	1.2670	1.7380	2.1000	2.500
11/32	0.077	0.1195	0.1718	0.2343	0.3058	0.4780	0.6875	0.930	1.2238	1.4080	1.9000	2.3100	2.750
3/8	0.084	0.1303	0.1875	0.2556	0.3336	0.5220	0.7500	1.020	1.3350	1.5480	2.0860	2.5200	3.000
13/32	0.091	0.1411	0.2030	0.2769	0.3614	0.5650	0.8125	1.105	1.4462	1.6890	2.2600	2.7300	3.250
7/16	0.098	0.1519	0.2187	0.2982	0.3892	0.6080	0.8750	1.195	1.5575	1.8290	2.4300	2.9400	3.500
15/32	0.105	0.1627	0.2343	0.3195	0.4170	0.6520	0.9375	1.280	1.6687	1.9700	2.6000	3.1500	3.750
1/2	0.112	0.1735	0.2500	0.3408	0.4448	0.6960	1.0000	1.365	1.7800	2.1110	2.7800	3.3600	4.000
17/32	0.119	0.1843	0.2656	0.3621	0.4726	0.7390	1.0625	1.450	1.8912	2.2520	2.9500	3.5700	4.250
9/16	0.126	0.1951	0.2812	0.3834	0.5000	0.7830	1.1250	1.535	2.0025	2.3930	3.1300	3.7800	4.500
19/32	0.133	0.2060	0.2968	0.4047	0.5278	0.8270	1.1875	1.620	2.1137	2.5330	3.3000	3.9900	4.750
5/8	0.146	0.2168	0.3125	0.4260	0.5560	0.8700	1.2500	1.705	2.2262	2.6740	3.4770	4.3000	5.000
21/32	0.147	0.2276	0.3281	0.4473	0.5834	0.9130	1.3125	1.790	2.3375	2.8150	3.6500	4.4100	5.250
11/16	0.154	0.2384	0.3437	0.4686	0.6112	0.9570	1.3750	1.875	2.4437	2.9560	3.8200	4.6300	5.500
23/32	0.161	0.2500	0.3593	0.4899	0.6390	1.0000	1.4375	1.959	2.5600	3.2380	4.0000	4.8400	5.750
3/4	0.167	0.2610	0.3750	0.5110	0.6670	1.0430	1.5000	2.044	2.6700	3.3790	4.1730	5.0500	6.000
13/16	0.181	0.2830	0.4060	0.5530	0.7220	1.1290	1.6250	2.214	2.8920	3.6590	4.5200	5.4700	6.500
7/8	0.195	0.2340	0.4372	0.5950	0.7780	1.2150	1.7500	2.384	3.1150	3.9400	4.8670	5.8900	7.000
15/16	0.209	0.2260	0.4684	0.6370	0.8340	1.3010	1.8750	2.554	3.3370	4.2200	5.2140	6.3100	7.500
1	0.223	0.3480	0.5000	0.6810	0.8890	1.3900	2.0000	2.720	3.5600	4.5050	5.5640	6.7300	8.000
1 1/16	0.237	0.3690	0.5312	0.7230	0.9440	1.4760	2.1250	2.890	3.7820	4.7850	5.9100	7.1500	8.500
1 1/8	0.254	0.3910	0.5624	0.7650	1.0000	1.5620	2.2500	3.060	4.0050	5.0650	6.2580	7.5100	9.000
1 3/16	0.268	0.4130	0.5936	0.8070	1.0560	1.6480	2.3750	3.230	4.2270	5.3450	6.6050	7.9900	9.500
1 1/4	0.282	0.4350	0.6248	0.8500	1.1110	1.7340	2.5000	3.400	4.4500	5.6250	6.9520	8.4100	10.000

Machinery

[1]For drilled holes, add weight of countersink to weight of body of hole.

Dynamic Balancing of High-speed Grinding Machine Motor Armatures

At the time when the Wisconsin Electric Co., Racine, Wis., first took up the manufacture of "Dumore" internal grinding machines, the first machine was built by hand under the personal supervision of Chester H. Beach, vice-president and

excellent work, the first lot of manufactured machines vibrated excessively under speeds of 30,000 to 40,000 revolutions per minute, and this vibration resulted in producing work on which the finish was entirely unsatisfactory.

It is possible that if the first machine had behaved in this manner, it would have been concluded that speeds of 30,000 to 40,000 revolutions per minute were impracticable and further development work on the "Dumore" grinder might have been dropped; but with 5000 sets of die-castings already produced by an outside firm, the money invested in the proposition made it imperative to try to bring the development of this machine to a satisfactory conclusion. Acting upon the hypothesis that trouble experienced in the operation of these machines was probably due to a lack of satisfactory balance, Mr. Beach started an investigation of the results obtained through running these grinding machines at different speeds, in order to determine whether this would affect the amount of vibration produced. When this was tried, some astonishing results manifested themselves. The most interesting of these was the fact that there were certain speeds at which an excessive amount of vibration was developed, while at other speeds the vibration would practically disappear.

These speeds varied for different cases, but in order to explain the exact nature of the phenomena, it may be stated that for a certain armature a considerable amount of vibration would be developed when running at, say, 10,000 revolutions per minute, and when this speed was increased to 15,000 revolutions per minute the vibration would practically disappear; for a further increase of speed to 20,000 revolutions per minute a most objectionable condition of vibration was again produced, etc. In other words, it was found that there were certain speeds at which a serious amount of vibration would be developed, while at other speeds—which might be either higher or lower than those at which there was an objectionable amount of vibration—the machine would run in a manner which was entirely satisfactory. It was assumed and later proved to be the case, that the armature of the first "Dumore" grinding machine which gave satisfactory results was in perfect dynamic balance, and so the problem of making the manufactured machines operate satisfactorily naturally resolved itself into a problem of developing means for dynamically balancing the armatures of these machines. Fig. 2 shows the apparatus which was finally developed for the purpose. In general, the design and principle of operation of this machine is the same as that of the Norton dynamic balance indicating machine shown in Fig. 1, so that a detailed description is not required.

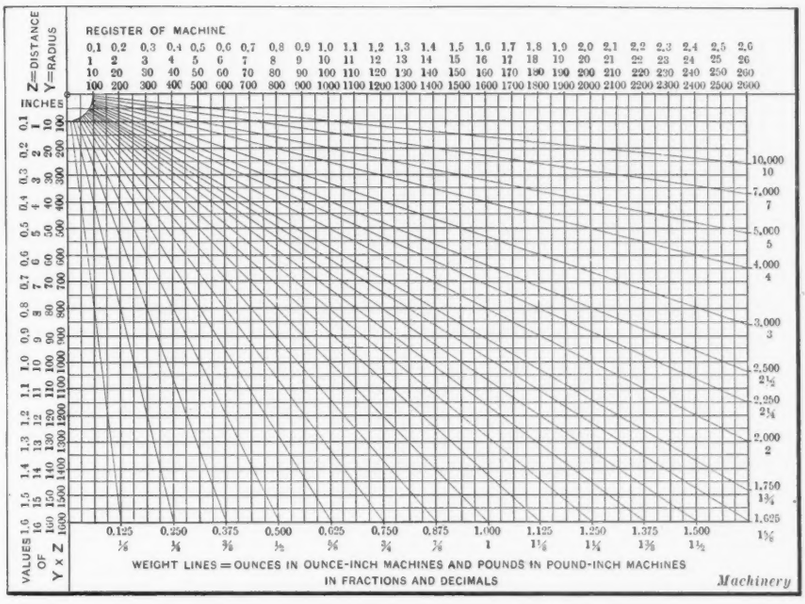


Fig. 4. Chart developed for Use with "Carwen" Dynamic Balancing Machine to determine Corrections that are Necessary for a Specified Value of Y times Z and a Given Reading of the Indicator J

"Carwen" Dynamic Balancing Machine

For use in bringing such members as electric motor armatures and automobile engine crankshafts into an accurate condition of dynamic balance, the Carlson-Wenstrom Co., Erie Ave. at Richmond St., Philadelphia, Pa., is now building machines of the type shown in Fig. 3. Several sizes are made to meet the requirements of plants building a variety of different sized products. The principle governing the operation of this equipment is based upon the tendency for an unbalanced machine member to cause vibration while rotating at high speed. It will be recalled that it is possible for a body to be in a condition of static balance when the conditions are as bad as possible for obtaining a condition of dynamic balance; that is, with an unbalanced weight at one end of the machine member and a corresponding unbalanced weight at the opposite end and diametrically opposed to the first point of unbalance. On the "Carwen" dynamic balancing machine, the bed is pivoted in such a way that it is free to vibrate when the member under test is out of running balance. Such vibration is shown by an indicator *A* placed at the opposite end of the machine bed from spring plates *B* which support the bed in such a way that it is free to have vibrations imposed upon it by the rotating member. At the opposite end of the bed from spring plates *B*, there are two compression springs *C*, which support the free end of the bed and are stiff enough to carry the weight, but not so stiff that they will retard vibration.

Suspended beneath the bed there is a balancing member *D*, the function of which is to provide an amount of unbalance equal to that which exists in the machine member under test, but applied in the opposite direction so that this balancing member will neutralize any lack of balance in the work and thus prevent vibration of the bed of the machine, as indicated by dial *A*. The balancing member *D* consists of two plates, one of which has a heavy point at its lower end while the other has a corresponding heavy point at its upper end. By turning handwheel *E*, these plates may be brought into contact with each other, when they will be in both static and dynamic balance, or they may be separated by turning wheel *E* in order to produce any required amount of lack of dynamic balance, although balancing member *D* will still be in static balance. Beneath the bed, at the right-hand end of the machine, there will be seen an electric motor *F* the speed of which is regulated by a controller. This motor is geared to the shaft on which balancing member *D* is carried and to the coupling which drives the work, both the balancing member and the work being driven at the same speed. In order to neutralize all tendency toward vibration produced by lack of balance in the work, it is necessary for the two plates to be sufficiently separated so that the product of the weight of unbalance multiplied by its radius from the axis of rotation multiplied by the distance between the two plates is equal to the corresponding product for the work.

Let us assume that the weight in ounces of each of the heavy spots on the balancing member *D* is represented by x, that the radius of these weights from the axis of rotation is y, and that the distance between the plates is z. Then the total measure of lack of dynamic balance will be xyz. Assuming corresponding capital letters for the work, we know that the total measure of lack of dynamic balance is XYZ, and in

order that indicator *A* will show no vibration, it is necessary to have:

$$xyz = XYZ$$

Not only must the magnitude of these two products for the work and balancing member be equal, but the position of the balancing member must be adjusted so that its plane of unbalance is the same as that of the work, with the weight in the opposite direction. This adjustment is made by rotating member *D* by means of handwheel *G* until the desired result has been accomplished, as indicated by a stationary position of the needle on indicator dial *A*. When this result has been obtained, it is required to know at which points on the work it is necessary to remove metal by drilling or to add metal in order to obtain an accurate running balance. This result is accomplished by turning a handwheel *H* in order to rotate both the balancing member *D* and the work until they reach such a position that a zero graduation on disk *I* is located directly beneath a stationary needle. When the balancing member is set in this position, the work has also been turned to such a position that balancing is accomplished by drilling a hole at the top of the work at the right-hand end and at the bottom at the left-hand end; similarly, balancing of the work may be accomplished by adding a weight at the left-hand end at the top and at the right-hand end at the bottom.

We have now ascertained the position of unbalance in the work and are ready to start the actual balancing operation, the first step of which is naturally to ascertain the amount of correction that must be made. This is shown by dial *J* which is so geared to the balancing mechanism that the turning of handwheel *E* both adjusts the distance between weights *D* and causes a corresponding movement of dial *J*. The graduations on this dial will vary according to the size of the machine, but where machines are used for balancing small parts, the readings are in inch-ounces, while for machines used to balance large machine members, the readings are in foot-ounces.

The Carlson-Wenstrom Co. has computed data showing the depth of holes ranging in diameter from ⅛ to 1½ inch, which must be drilled to remove a specified number of ounces of metal. These data are given in the accompanying table. Also a chart has been drawn as shown in Fig. 4. This gives the reading of dial *J* along the upper margin and the value of the radius *Y* multiplied by the length of the work *Z* along the left-hand margin. This chart is valuable for use in cases where a number of duplicate parts have to be balanced on which the value of the radius times the distance between opposite ends of the work is constant. The reading of dial *J* will, of course, vary according to the amount of unbalance existing in different pieces of work, and in using the chart, the operator runs down the vertical line under the dial reading until he strikes the horizontal line through the constant *YZ* for the work. He then runs down the diagonal line to the lower or right-hand margin of the chart, to find the number of ounces of metal which must be removed at each end of the work, in order to produce an accurate condition of dynamic balance. With this information available, he can then refer to the table to determine the depth of hole for a drill of specified diameter. It will be seen that at both the left-hand and top margins of the chart, four sets of values are given, each of which is ten times the preceding value. Arranging the chart in this way makes it possible to have a single chart which is adaptable for use on machines of all sizes, but in using any of these different sets of values, the machine operator must be careful to make a corresponding correction of the position of the decimal point in the figure designating the amount of metal to be removed from the work. This is done by multiplying by 10, 100, or 1000 for the second, third, or fourth line from the top in the values for the dial reading; and by dividing by the same factors for corresponding lines of the values of *YZ*.

Fig. 3 shows one of the "Carwen" dynamic balancing machines as used at the plant of the Westinghouse Electric & Mfg. Co. The method of using this machine is in accordance with the previous description. In balancing certain parts, this firm makes a practice of drilling and tapping holes around the periphery at each end of the work. Then, after the plane of unbalance has been determined, it is easy to make correction by screwing the required number of threaded plugs into these holes. This is, perhaps, a simpler method of balancing than to resort to the practice of drilling or grinding away metal.

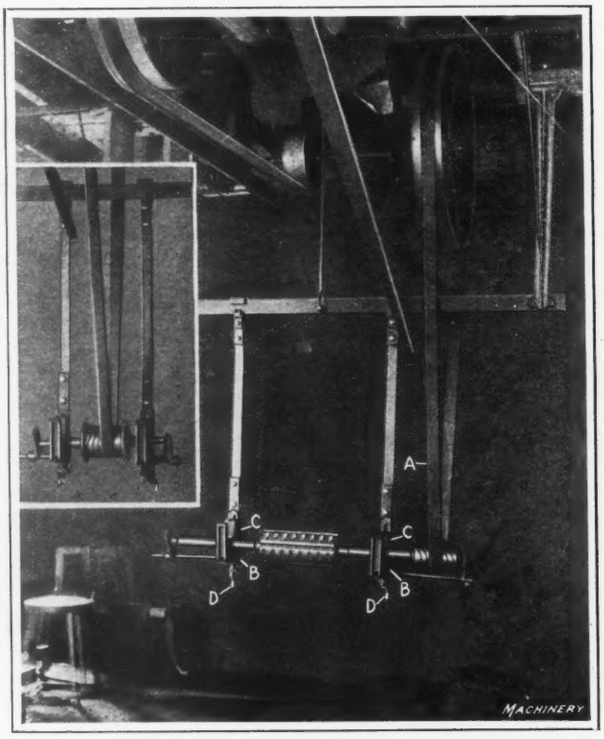


Fig. 5. Special Dynamic Balancing Equipment used by the S. A. Woods Machine Co. for balancing Parts of High-speed Woodworking Machinery

Bringing Pulleys and Shafts of Woodworking Machinery into Dynamic Balance

In connection with the construction of various types of woodworking machinery built by the S. A. Woods Machine Co. of Boston, Mass., two interesting methods are used for bringing high-speed shafts, pulleys, cutter-heads, etc., into dynamic balance. The machine used for balancing members of considerable length was developed by C. G. Osteman, mechanical engineer of the S. A. Woods Machine Co., while the machine used for balancing pulleys and similar shaped pieces is the standard type of equipment built by the Defiance Machine Works, of Defiance, Ohio. The method of procedure followed in bringing a member into accurate dynamic balance through the use of either of these equipments will be described in detail. Fig. 5 shows the special machine developed for use in balancing shafts and other members of considerable length. Mention has already been made of the fact that in case of a lack of dynamic balance, there is a tendency for the rotating member to change its axis of rotation from the line of bearing centers to an axis through the center of gravity of the work. The idea of this dynamic balancing machine is to furnish a means of rotating the member at high speed while it is freely suspended in the air, thus affording an opportunity for the effect of lack of dynamic balance to manifest itself.

The member to be balanced is supported in a sling and driven by a belt *A* from an overhead countershaft in such a way that it runs at approximately 5000 revolutions per minute. At each end of the shaft there is a half bearing *B*, which is supported by a canvas belt *C* connected to the machine frame. This flexible method of support places the machine member which is to be balanced under practically no restraint, and as a matter of fact, the bearings *B* have little influence in supporting the work, most of the load being

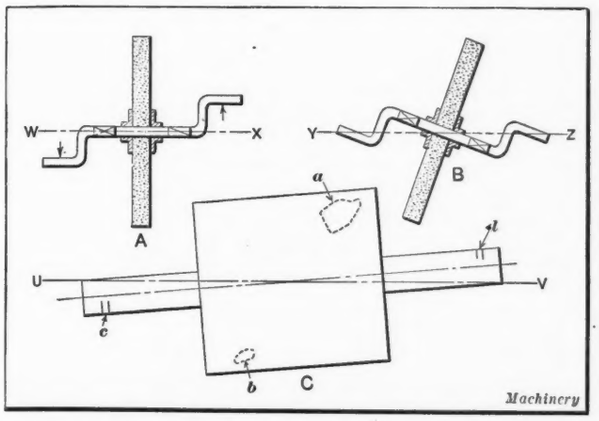


Fig. 6. Diagrams A and B illustrate Principle governing Operation of Machine shown in Fig. 5; Diagram C shows why Marks are made on the Light Side of the Work

carried by belt *A*. Beneath each of the end bearings there is a small crank *D* which actuates an adjusting screw to provide for raising or lowering the bearing, in order that the work may be satisfactorily leveled up and also to provide a means for compensation in handling pieces of various diameters without changing the length of belt *A*.

In balancing a machine member in this equipment, the method of procedure is first to get the work running as smoothly as possible, after which a piece of soapstone, which has been trimmed up to a sharp edge along one side, is very lightly applied to the rotating shaft so that it will just touch the high side, but will fail to touch the low side. The presence of these high and low sides, as they are called, is the result of the shaft rotating about an eccentric axis through the center of gravity, owing to its lack of balance. After a mark has been made with the shaft rotating in one direction, the direction of rotation is reversed by means of a controller connected to the countershaft and another mark is applied with the work rotating in the opposite direction. The central point of the space where these marks overlap, indicates the light side of the shaft and at a point diametrically opposite, metal must be removed by drilling a hole until the necessary correction has been made to bring the piece into accurate running balance.

In the case of cutter-heads for wood planers, the method of procedure is to first accurately balance the pulley at each end of the cutter-head arbor, after which the arbor is balanced and then the three pieces are assembled and tested as a unit to see that the assembled machine member runs properly. This calls attention to a general principle of fundamental importance in conducting work of this kind, namely, that the various parts of an assembly may be balanced individually and then assembled. Normally, this will assure the assembled machine member also being in dynamic balance. But after balancing, no adjustments of any kind can be made on any member of the assembly without danger of seriously affecting the dynamic balance of the entire machine member.

In order to give a clear idea of the principle governing the operation of this machine, and the reason why the chalk marks are made at the light side of a rotating member in which there is a lack of dynamic balance, attention is called to the diagrams shown in Fig. 6. This illustrates the conditions governing rotation of the familiar grindstone and the hand-cranks at opposite sides by means of which it is turned. At *A* the outfit is shown supported in rigid bearings, and where there is a noticeable lack of dynamic balance the result will be that the shaft tends to find a center of rotation about a line through the center of gravity instead of through the axis of these bearings. The result will be that an excessive pressure will be applied at the upper edge of one bearing and the lower edge of the opposite bearing causing excessive wear at these points. Under extreme conditions of speed and lack of balance, such an excessive amount of vibration and wear may be set up that the bearings will be actually broken. At *B* is shown the manner in which the crankshaft tends to change its axis of rotation from the line of bearing centers to an axis through the center of gravity. In diagram *B* it is assumed that the shaft is rotating in free space at high speed, without any form of restraint from the bearings. Under such conditions the axis of rotation will be changed from line W–X of diagram *A* to line Y–Z of diagram *B*.

In order to explain the way in which the chalk mark is applied to the light side of a rotating body, where there is lack of dynamic balance, attention is called to diagram *C* of Fig. 6 which shows the driving pulley of a cutter-head for a wood planing machine as it is set up to be balanced. The piece has been accurately machined so that it is concentric with the geometrical axis and should be in accurate static and dynamic balance if there is no lack of homogeneity in material. Suppose, however, that there is a blow-hole as indicated at *a* and a second blow-hole as indicated at *b*. We assume that blow-hole *a* is larger than hole *b*, so that the heavy side will be slightly below the geometrical axis. As a result, the axis of rotation will change from the geometrical axis, to an axis U–V which passes through the center of gravity. It will then be apparent that when the soapstone with a sharp edge is applied to the shaft it will make marks at points *c* and *d* which represent the light side of the shaft in each case. When these light sides have been determined, correction must be made by drilling away metal at points diametrically opposite to compensate for the lack of balance. Where there is a substantial error in balance, these marks will be quite short and will indicate the light side quite distinctly. However, where the lack of balance is small, the soapstone line will run almost all the way around the shaft, and in such cases it is often easier to locate the heavy side at the point midway between the ends of the line, that is, the middle of the short interval at which the chalk does not touch the rotating shaft.

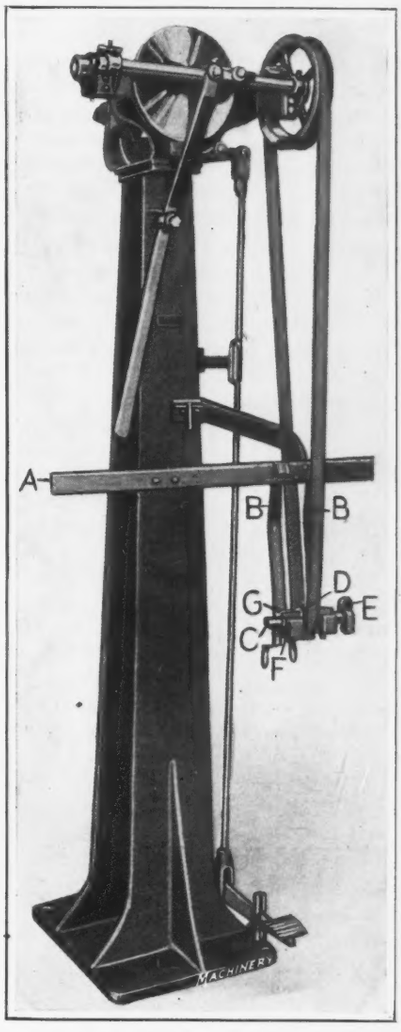


Fig. 7. Commercial Dynamic Balancing Machine built by the Fitz-Empire Double Pivot Last Co.

Machine Applying Principle of Equipment shown in Fig. 5

The Fitz-Empire Double Pivot Last Co., Rochester, N. Y., is now building for the market a standard dynamic balancing machine which employs a similar principle of operation to that of the machine shown in Fig. 5, and as a complete description of the operation of this machine was given in the preceding paragraphs, it will merely be necessary at this time to present a brief outline of the features of the Fitz-

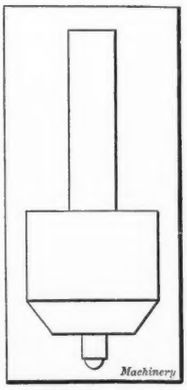
Empire machine which is shown in Fig. 7. Here it will be seen that bar *A* supports two arms *B* which carry the bearings that support the work *C* to be balanced. It will be apparent that this work has a pulley *D* over which the driving belt runs. The bearings consist of aluminum castings *F* and aluminum U-shaped boxes *G* with an elastic felt packing interposed between the two bearing members. As both the arms *B* and the bearing members *F* and *G* are free to vibrate, it will be apparent that the work can move in any direction according to the forces applied to it through lack of balance. The foot-treadle provides for engaging or disengaging a brake to rapidly stop rotation of the machine and work; and the vertical hand-lever at the front of the column enables the speed to be regulated or the direction of rotation to be reversed. Otherwise, the method of procedure in balancing is the same as that which has just been described. It is stated that experienced men engaged in balancing 6- by 6-inch cast-iron pulleys are able to obtain a good condition of dynamic balance on 80 per cent of the pieces by putting them back in the machine a second time, that is to say, by applying two sets of markings. The time required to balance such pieces will average ten minutes. The machine has a capacity for balancing light-weight rotating parts of high-speed machinery which range from 1 ounce to 75 pounds in weight, and the arms *B* may be adjusted along bar *A* to provide for balancing work up to 32 inches in length between the bearings.

* * *

DEVICE FOR TESTING HARDNESS OF MATERIALS COMMERCIALLY[1]

BY J. G. AYERS, JR.

In the ordinary Brinell machine, several seconds are required to bring the full load to bear upon the ball and test specimen and this pressure must be maintained for some time. When time is not as important as accuracy, this procedure is all right; but when the testing must be done on a commercial scale, as in the acceptance of raw material, rapidity and approximate determinations are of greater importance. The writer has tried to devise a simpler machine that will give satisfactory results in tests made on a commercial scale. Instead of applying a standard dead load, as in the ordinary Brinell machine, a given impact is used. It is, of course, impossible to choose a standard impact that will produce the equivalent Brinell impression in a steel of any hardness, but for a given hardness it is possible to determine empirically the impact required to produce an impression identical with the one produced by the standard Brinell machine. The impact chosen is that which gives a 3-millimeter diameter impression in a steel of 418 Brinell hardness. This impact will give the same result on a steel of this hardness as the standard Brinell machine, using the 10-millimeter ball and a 3000-kilogram load and is obtained by dropping the cylindrical 10-kilogram weight shown in the illustration a distance of 70 millimeters. As it is sometimes advisable to use a lighter load than 3000 kilograms with a standard Brinell machine, it is also possible to obtain a different impact by varying the distance of the fall of this weight. The diameters of the impressions of the ball dropped through distances of 36 and 70 millimeters in steels of different degrees of hardness are given in the accompanying table.



Cylindrical Weight and Ten-millimeter Ball

As in the case of the standard Brinell machine, there are certain limitations to all ball hardness testers. In those cases in which the metal is extremely hard a permanent deformation of the ball results. Where the test specimen is soft, the ball penetrates so closely to the supporting surface, or anvil, that the hardness of the latter affects the results. Small narrow specimens of hard steel crack under test, and soft narrow ones permit of an easy lateral flow which affects the accuracy of the test. Fortunately, with the exception of thin pieces such as sheets, none of the above cases are so extremely common as to curtail the use of the Brinell machine. In the case of thin soft sheets, by reducing the load to 1000 kilograms or by reducing the size of the ball consistent results can be obtained; with the device described it is necessary to use a smaller ball and less impact. In the standard Brinell machine there are only two factors which can be varied, namely, the load and the size of ball. In the device described, the weight, the height, and the diameter of the ball may be varied. Just what values will eventually be assigned to these factors has not as yet been determined.

In designing a machine upon the principle described, it is possible to have it either hand- or power-operated. The weight can be raised and tripped at as rapid a rate as the samples can be supplied and removed, so that it will work if required with the regularity of a shear or punch press. The cost of manufacture will be less than that of the standard Brinell machine, since there are fewer accurately machined parts required, and this, together with the rapidity with which tests can be made, should create a useful field for the device.

[1]Abstract of a paper presented to the American Society for Testing Materials at Atlantic City, June, 1918.

BRINELL HARDNESS NUMBERS FOR AYERS-BRINELL MACHINE WITH 10-MILLIMETER BALL AND 10-KILOGRAM WEIGHT

Diameter of Ball Impression, Millimeters	Hardness Numbers		Diameter of Ball Impression, Millimeters	Hardness Numbers		Diameter of Ball Impression, Millimeters	Hardness Numbers		Diameter of Ball Impression, Millimeters	Hardness Numbers	
	36-millimeter Fall	70-millimeter Fall		36-millimeter Fall	70-millimeter Fall		36-millimeter Fall	70-millimeter Fall		36-millimeter Fall	70-millimeter Fall
2.00	629	838	2.50	419	628	3.00	209	418	3.50	...	208
2.05	608	817	2.55	398	607	3.05	188	397	3.55	...	187
2.10	587	796	2.60	377	586	3.10	167	376	3.60	...	166
2.15	566	775	2.65	356	565	3.15	146	355	3.65	...	145
2.20	545	754	2.70	335	544	3.20	125	334	3.70	...	124
2.25	524	733	2.75	314	523	3.25	104	313	3.75	...	103
2.30	503	712	2.80	293	502	3.30	83	292	3.80	...	82
2.35	482	691	2.85	272	481	3.35	62	271	3.85	...	61
2.40	461	670	2.90	251	460	3.40	41	250	3.90	...	40
2.45	440	649	2.95	230	439	3.45	20	229	3.95	...	19

Machinery

* * *

Pure sheet nickel for household utensils is essentially an American product. It does not rust or oxidize; consequently the danger of poisoning generally caused by verdigris, is eliminated. It will not tarnish like silver, and while not as good a heat conductor as aluminum, nickel utensils are made of thinner material, which more than compensates for the difference in conductivity. The melting point of nickel is 2600 degrees F., whereas that of aluminum is only 1200 degrees F. Nickel is also much more resistant to the action of acids, particularly those commonly found in food, and is practically immune to the attacks of all alkalies.

CHINA AS A MARKET FOR MACHINE TOOLS

BY P. J. RASMUSSEN

Engineer, Nielsen & Winther Co., Copenhagen, Denmark

The writer of this article is now on his way to China where he will build, equip, and temporarily manage a munition factory built by the Chinese Government as part of the Kung Hsien Arsenal. This factory will be equipped with machine tools and special ammunition machinery built by the firm of Nielsen & Winther Co., Copenhagen, Denmark.

THOSE who are familiar with conditions in China are predicting that after the war there will be a rapid development of Chinese industries. This development will require machine tools, because the machine tool is a fundamental and necessary accessory to every industry. The transportation system of China will be developed in an ever-increasing ratio. This means more railroad shops with their machine tool equipment, and gradually plants for building railway cars and locomotives. Furthermore, China is now developing means to overcome its military helplessness in regard to other aggressive nations, and has built and is still building arsenals and factories for the manufacture of arms and ammunition. These will require machine tools of the highest class. Europe is reaching out for this trade with a very definite purpose, and it is likely that American machine tool builders will also appear in the Chinese market after the war in greater numbers than in the past. Conditions in China are favorable to a great industrial development, and it is likely that the future will see a rapid advance in all the fields of industrial endeavor. Some of the ideas in the following paragraphs were given to the writer by F. C. Mathiesen, of Pekin, China, an engineer intimately acquainted with Chihese conditions, who has lived and has been engaged in business in China for more than ten years.

Reasons Why There will be a Great Industrial Development in China

It is likely that within the next few years, American, European, and Japanese capital will become interested in the industrial development of China and that factories will be built in China for producing many products for local consumption, instead of importing products made in America or Europe. This is particularly true of articles that can be manufactured to advantage with cheap labor and under the prevailing conditions in China. The reasons why it would be more advantageous to make products of this kind in China than to attempt to ship them to the country are, that there is an abundance of cheap coal, an abundance of cheap labor, great quantities of raw materials of nearly all kinds, and low taxes. In addition, the high freight charges for carrying manufactured goods from America or Europe to China will induce capital in many lines to operate directly in that country. To equip these factories, however, will require a great deal of machinery built in America or Europe, and here is an opportunity for the machine tool builder to establish himself in China in such a manner that when this trade becomes available, he is ready to take advantage of the opportunity.

There are, of course, some objections to the establishment of industries in China, chief of which is the unstable political situation. This, however, does not affect the so-called "foreign settlements," because these are fully protected by their respective European governments. Another objection is that at the present time the amount of iron and steel produced in China is comparatively small, and not enough for any great industrial expansion. Gradually, however, this condition will be overcome, and during the development there will be a great call for machinery and machine tools in order to equip the iron and steel industry.

Comparison between China and Other Asiatic Markets

As compared with Siberia, which is as rich as China in coal, and a great deal richer in iron and other metals, China has many advantages. The most important is that Siberia is poor in good labor, while China is extremely rich in this respect. The climate is more advantageous in China, and the transportation facilities are a great deal better. China has a network of railways which is constantly increasing, and its rivers and system of canals provide an inland navigation facility of great importance. Large steamers can carry freight as well as passengers along the Chinese rivers far into the country, and a great many good harbors along these rivers make the transportation problem an easy one. Altogether, there are great opportunities in prospect for the importation of machinery of all classes, including machine tools, steam engines, pumps, and mining machinery. In some portions of China water power is available, making it possible to develop a trade in hydraulic machinery and electrical machines.

Methods of Operating a Business in China

There are three specific methods that may be used in selling machinery in China.

1. An American or European machine builder may establish a Chinese branch house managed by Americans or Europeans, which would sell directly to Chinese and other companies requiring machinery for industrial undertakings. This method, of course, can be employed only by very large builders of machine tools.

2. The machine manufacturer may be represented in China by a large American or European selling organization, which has an office of its own conducted and run entirely by Americans or Europeans.

3. American or European capital may cooperate with Chinese capital in such a way that the control still remains in America or Europe, as far as both the commercial and the engineering sides are concerned. In this case the selling company may have Chinese directors and a number of Chinese officers. This method has a great deal to commend it, providing the Chinese officers are carefully selected. The advantages may be summarized as follows: The Chinese customers will have much greater faith in the undertaking if it has been proposed and is backed by Americans or Europeans; on the other hand, the Chinese authorities are likely to look more favorably upon a company of this kind than they would upon one that is purely foreign. In fact, selling agencies or companies made up partly of Chinese and partly of foreign business men are more successful, as a rule, than those that are either purely foreign or purely Chinese. Purely native companies are generally "squeezed" by the authorities, while foreign concerns are often embarrassed in various ways. It appears that the combination of foreign and Chinese capital and management is generally treated better by the Chinese authorities, and the combination is also more popular in China, which is an important factor.

The Chinese are very willing to enter into such partnerships, as they recognize that, on the whole, the American or European will give them an honest administration and that he is technically superior. They especially favor this arrangement if the leading men in the organization being formed have some knowledge of China. Of course, considerable care must be taken in forming such partnerships.

After his long experience in China and dealings with Chinese business men, Mr. Mathiesen states that business men in the province of Canton are by far the most intelligent and enterprising of any to be met in China, and here the largest amounts of capital are also to be found. The Chinese in Singapore (Straits-settlement Chinese) should also be considered in conjunction with any business dealings with China. Much business in China can be conducted from

there. There is a better understanding of big commercial enterprises in Singapore than there is in China, and here one also finds a reliable and experienced merchant class, which has considerable interest in new enterprises in China proper. At the same time, the Singapore Chinese are English citizens, and consequently they are amenable to British law.

It has been the custom in the past for many European machine building firms to sell machinery without requiring cash payments (although at high prices). The payment for the machinery has remained as a first mortgage on the undertaking, but this must not be considered good business policy unless the seller also retains a commercial and technical control in the new Chinese undertaking.

Both Europe and Japan will probably work along the lines mentioned in the preceding paragraphs, and those who step into China at the present time are likely to get in on the ground floor. American machine tool builders and manufacturers of other classes of machinery for which there is a market in China will no doubt also adopt some definite policy with regard to Chinese trade. There is a great industrial development to be expected in China in the comparatively near future.

* * *

DEVELOPMENT OF ELECTRIC CAST-STEEL ANCHOR CHAIN[1]

At the time that the present large shipping program of this country was decided upon, it was at once obvious that the United States was not prepared to furnish many things required in the construction of ships. Anchor chain, of which the average sized merchant vessel requires about 30 tons, was one of these. For a program of 1500 ships this item alone would aggregate approximately 45,000 tons, or over five 8000-ton shiploads of chain. The anchor chain used in the United States has, for the most part, been of foreign manufacture, although the Navy has manufactured most of its chain at the Charlestown Navy Yard. The universal method of manufacturing chain has, in most cases, been by hand forging. A gang of chain makers could produce but a few lengths per day, and it therefore was at once evident that a new process for making the chains must be developed if the new demands were to be met.

Different Methods Tried for Speeding up Production

With a view of solving this problem, investigations were made at the request of the Shipping Board. From an engineering standpoint, although the problem seems simple, the factor of mere strength did not prove to be of primary importance. From a nautical viewpoint, the weight of the chain per fathom for a given size of ship was the important requirement. The first consideration was the substitution of electric welding for the hand method. This was successfully done; but this means simply speeded up one of a number of operations necessary in the production of chain. It was then decided that at least every other link could be drop-forged to shape, including the stud, and that the alternate link could be welded by hand, machine, or electrically. A set of dies for two-inch chain was accordingly made and a number of links was forged. Tests showed them to be successful. It was thought that the Fleet Corporation would be able to obtain drop-hammers in various parts of the country, order links forged from cast ingots, and have the links shipped to chain shops where they could be welded into finished chain, thereby materially reducing the labor on half the production. This method, however, did not particularly adapt itself to the heavier chain, as it is much easier for a chain maker to weld a link at the end of a chain than to connect two pieces of chain; and while it would have undoubtedly speeded up the production, on the whole it would have handicapped that part of the process in which hand welding would be employed.

[1]Abstract of an article by W. L. Merrill, Power and Mining Engineering Department, General Electric Co., in the "General Electrical Review."

Casting Electric Steel Anchor Chain

Thus it appeared that any process for making chain which would make a real reduction in the over-all labor time must involve some radical change from the conventional method. Hence, a method of casting the chain was evolved. One of the earlier cast-steel chains was made by casting one link at a time with the molds interlocked. The diameter of the link was 7½ inches and the length 36 inches, and this chain is in service at the present time. It appeared possible, however, to cast much smaller chain than this by the use of electric steel, and accordingly samples were made that proved this to be true. In the first attempt, the studs were placed in position after the links were cast, the same as in hand-welded chain. Attempts to cast chain in permanent molds were also made. It was found, however, that this was not feasible for large production, since there is a very critical time at which the molds should be opened so that cracks caused by shrinkage may be prevented. Therefore, dry sand molds were used and successful chain was made by this method.

Strength of Electric Steel Chain

The first samples tested at the Bureau of Standards showed nearly double the strength of wrought-iron chain. However, it was thought by some that further tests should be made before adopting the chain. There seemed to be some concern regarding the comparative corrodible qualities of electric steel and wrought iron. There being, however, no reliable data available on wrought chain, it was felt that the life of electric steel in comparison would at least be sufficient for the emergency at hand, and consequently the question of corrosion was dismissed. Data collected from various sources showed that practically all anchor chain failures were due to accident rather than normal conditions. Comparative tests were made by subjecting single links of wrought chain and electric steel chain to a blow under a drop-hammer, which action somewhat approximates that of the abnormal conditions that anchor chain must withstand. Neither link failed, but the electric steel link showed less deformation than the wrought link.

Investigations on automatic machine molding possibilities were made, and resulted in developing a process for molding chain in sections complete, with the studs cast integral, and successful results were obtained in several foundries. At the present stage of development, chain with links of 1⅜ inch diameter is apparently the smallest that it is practicable to mold.

The American Bureau of Shipping, American Lloyds, and English Lloyds, have approved and issued specifications permitting the use of electric steel anchor chain on shipboard. These specifications differ in the main from those required for wrought chain in that the original breaking test of wrought chain is now specified for the proof-test of electric steel chain, with proportional increase in tests for sample links above this of 40 per cent, and in addition, to this is added a shock bending test for sample links.

* * *

RUST PREVENTIVES

The following anti-rust compound for machinery will give satisfactory results if care is taken first to properly clean the parts which are subject to rust with fine emery cloth and oil. Dissolve one pound of lard and one ounce of camphor. Remove the scum and stir in enough powdered graphite to give the mixture the color of iron. Apply to the desired parts and after twenty-four hours, clean the surface with a soft cloth.

For tools, vaseline is a good rust preventive. Of course, tools which are rusty must be cleaned with French emery paper and oil before applying the vaseline. A good suggestion to toolmakers and machinists as an anti-rust measure is to apply a little vaseline to the hands when handling tools, since freely perspiring hands are likely to cause the tools to rust. G. B.

RECONSTRUCTION CONFERENCE OF AMERICAN INDUSTRIES

CONFERENCE OF MORE THAN THREE HUNDRED AND FIFTY AMERICAN INDUSTRIES TO BE HELD AT ATLANTIC CITY, DECEMBER 3 TO 6

ON December 3, the War Service Committees of more than three hundred and fifty industries, consisting of prominent manufacturers and representing practically every trade and industry in the United States, will meet in separate meetings at Atlantic City, N. J., under the auspices of the War Service Executive Committee of the Chamber of Commerce of the United States. At these meetings, policies will be formulated for the industries represented by the committees, and these policies will be given definite form in resolutions and recommendations which will be presented during the conference on the following three days. This is probably the largest and most representative gathering of manufacturers and industrial men that has ever taken place, and it is believed that the results from the conference will have an important bearing upon the great questions to be decided in connection with reconstruction for peace.

The manner in which the Chamber of Commerce of the United States has organized the industries, under the direct supervision of W. H. Manss, director of the War Service Executive Committee, is very thorough. Three hundred and fifty-seven industries or trades have been requested each to go to Atlantic City and there represent the trade. These committees have not been created over-night, but the work of selecting and appointing them has proceeded for many months. The numerous trade committees, in turn, will be combined into some thirty larger groups known as "related" groups, and these groups will be classified into ten "major" groups. The method that will be followed at the meeting will be to have the individual trade committees meet separately on December 3 and formulate their respective policies; then the related groups will meet on December 4 and the policies already formulated by the smaller committees will be passed upon by these larger groups. Finally, on December 5, the policies adopted by the related groups will be considered by the major groups and definite action taken. Careful plans have already been laid for the meeting, and the subjects of prime importance to be discussed have been submitted to the industrial representatives. Among the many subjects that have been proposed are the following: Methods to be followed in the cancellation of government war orders, so that there will be the least amount of hardship on the industries and so that there may be a gradual and simple readjustment to normal commercial conditions; suggestions relating to the continuation, during the period of reconstruction, of the War Industries Board, or of any of its divisions, or of any other governmental department created specifically for the war period; the question whether such boards or departments should have the authority to control materials and regulate prices; the disposition to be made of the government merchant marine; problems relating to foreign commerce and the effect of the Webb-Pomerene bill, which allows combinations for foreign trade, and how the provisions in this bill may be realized in practice; methods for determining the needs of the Allied countries for rehabilitation, and the extent to which the United States can supply both raw and finished materials to these countries until they have been reconstructed; questions relating to the appointment of a committee by the manufacturers of the United States to confer with similar committees of the Allied nations to formulate international plans for protecting industry during the reconstruction period.

Labor questions will also be taken up and it is expected that definite policies will be adopted. Among the questions thus proposed is one relating to how the men returning from the front may be best absorbed in the industries without adversely affecting the present workers in these industries. Management and financial problems will also be taken up. Among the questions thus dealt with will be those relating to orders placed at war prices, but not delivered; effect of increased taxes and rates of interest; effect of the Government selling materials, machines, and industrial products in the open market, when these materials, machines, or products will no longer be required by the Government.

These and a great many other questions will be brought up in the smaller committees, and then be placed before the major group meetings for final action. Permanent committees will be formed for carrying into effect the resolutions adopted, and it is believed that by this means it will be possible to obtain a concerted action on the part of the manufacturers of the country, and that definite policies will be formulated which the manufacturers will find it possible and safe to follow. The conference will be addressed by the Secretary of War, the Secretary of the Treasury, and the Secretary of Commerce. It is hoped that these addresses will aid in giving the manufacturers a definite idea as to what the future policies of the Government will be in the most important branches of governmental service. It has been suggested that the nation should enter upon the reconstrcution period in the same spirit as that with which we entered upon the war—the spirit of honesty, justice, and humanity.

AN ACCURATE PREDICTION

On August 15, 1914, two weeks after the beginning of the war, Alexander Luchars, publisher of MACHINERY, wrote an editorial which was published in the September number of MACHINERY, in which he predicted very accurately the conditions that now, four years and three months later, we find have come true. The following quotations from the editorial published are of great interest in view of the developments during the past four years:

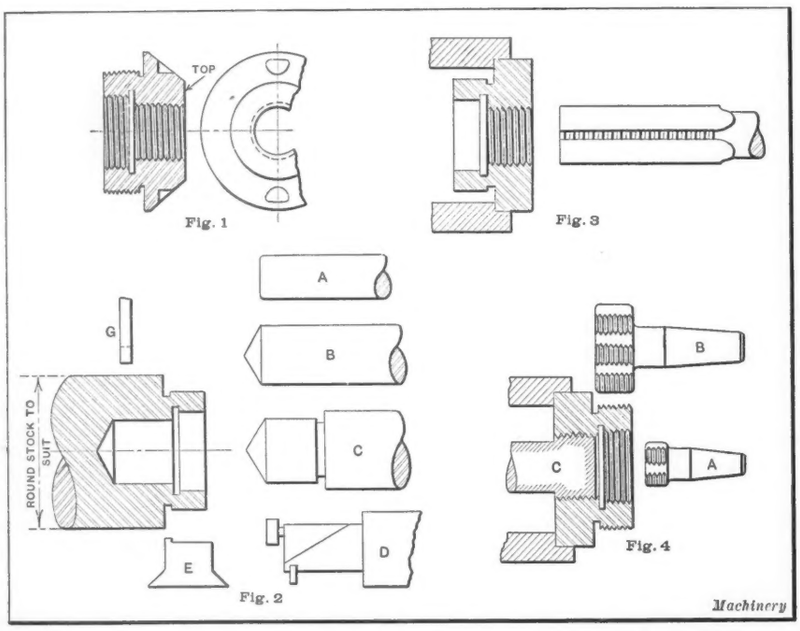
> "Whatever happens to the three emperors who are responsible for the war, one result will surely be the transfer of some of their power to the people of Germany, Russia, and Austria.
>
> "The strength and military training of the Germans have made them over-confident, and begotten a war madness which will check their commercial progress for a generation. This was very noticeable when the writer was in Germany last summer during the break with England. The war fever possessed nearly everyone, and only a spark was then needed to start the conflagration.
>
> "Germany.....is hated and feared by all of Europe except Austria.....
>
> "It will be years before the trade of Germany can recross the bloody barriers which will separate her at the close of the war from the countries she is seeking to destroy."

MACHINERY was the first technical, engineering, or trade journal to take a definite stand with regard to Germany's position, and the first journal that predicted the exact outcome of the conflict, due mainly to the fact that its publisher had, for years previous, given very close attention to European trade and conditions in general; and had traveled extensively in Europe where he had a large circle of friends and acquaintances, through whom he had first-hand and accurate information as to the actual internal conditions and feelings in the various European countries.

ERIK OBERG

METHODS EMPLOYED IN MACHINING ADAPTERS

BY M. H. POTTER



Figs. 1 to 4. High-explosive Shell Adapter and First Four Operations in machining it

MANY orders have been placed with manufacturers by the Ordnance Department of the United States Army for high-explosive and gas shell adapters. Although the operations are few and not particularly complicated, some manufacturers have experienced considerable trouble in meeting the requirements of the government inspection. The high-explosive adapter is subject to two concentricity tests, while the gas shell adapter is gaged but once for concentricity. The greatest trouble in producing work which could be satisfactorily passed has been due to the difficulties met with in this concentricity gaging.

High-explosive Shell Adapters

The adapters for the high-explosive shell are machined as shown in Figs. 2, 3, 4, and 6, when the threads are milled, and as in Figs. 2, 3, 4, and 5, when the threads are cut. The completed adapter is shown in Fig. 1. The outside diameters of the finished adapters range from 1.85 to 2.37 inches, depending upon the size of shell for which they are intended.

The first operation, which is shown diagrammatically in Fig. 2, consists of boring and finishing the hole, under-cutting, rough-forming, and cutting off. Referring to Fig. 2, *A* is the stop; *B*, the drill; *C*, the two-step reamer; *D*, the automatic under-cutting tool; *E*, the rough-forming tool; and *G*, the cutting-off tool. The second operation, shown in Fig. 3, consists of tapping the upper interior thread. The piece is chucked as shown.

Operations 3 and 4, illustrated in Fig. 4, consist of milling the lower interior and the exterior thread. The tools are the two milling cutters *A* and *B*. In this operation it is very important that the piece be centered so as to be concentric with the hole tapped in Operation 2. In order that this may be accomplished satisfactorily the work is centered on the threaded arbor *C*.

The fifth operation, shown in Fig. 6, consists of rough-forming the taper on the head, cutting to length, and finish-forming the taper. The tools are shown in the illustration at *A*, *B*, and *C*, respectively. During this operation it is not vital that the piece be centered by the same method as in the previous operation, although this may be found a convenient method of chucking.

If it is not convenient to mill the threads as shown in Fig. 4, they can be cut as shown in Fig. 5. The piece is chucked as shown, and the exterior thread cut with the self-opening die-head *A*. The larger interior thread is cut with the collapsible tap *B*, and the smaller hole with a tap similar to that shown in Fig. 3. After the piece is burred, it is completed as far as the machining operations are concerned and is ready for the final inspection. The adapters are gaged after each operation.

Gas Shell Adapters

The gas shell adapters are made of hexagonal stock and are machined to the shape shown in Fig. 7. The sizes vary from 1.94 to 3.46 inches outside diameter. The first operation is shown in Fig. 8, *A* being the stop; *B*, the drill; and *C*, the self-opening die-head for the exterior thread of the adapter; *D*, the rough-forming tool; *E*, the tool for forming the lip to size; *G*, the grooving tool; and *H*, the cutting-off tool.

The second operation is shown in Fig. 9, *A* being the two-step reamer; *B*, the tool for cutting to length; *C*, the collapsible tap for cutting the interior thread; and *D*, the tool for forming the chamfer. When the tools are available for milling the threads, this process is preferable to the method described. Both the high-explosive and the gas shell adapters are finally zinc-plated.

As previously stated, the concentricity gaging is the most important and the one which causes the greatest number of rejections. The other gaging consists of both "Go" and "Not Go" thread plugs, and of plain plug and ring gages. The tolerances on both the threaded parts and other dimensions are quite liberal. The thread tolerances vary from 0.009 to 0.018 inch. For the other dimensions the tolerances range from 0.015 to 0.040 inch.

While the methods described are in no way unusual, they present good manufacturing practice; hence, they are applicable not only in the manufacture of war materials, but also in producing similar parts for devices used in peace.

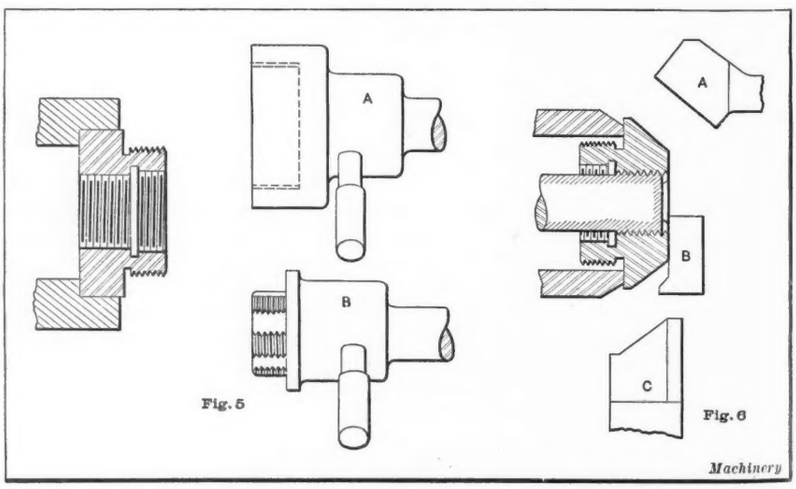
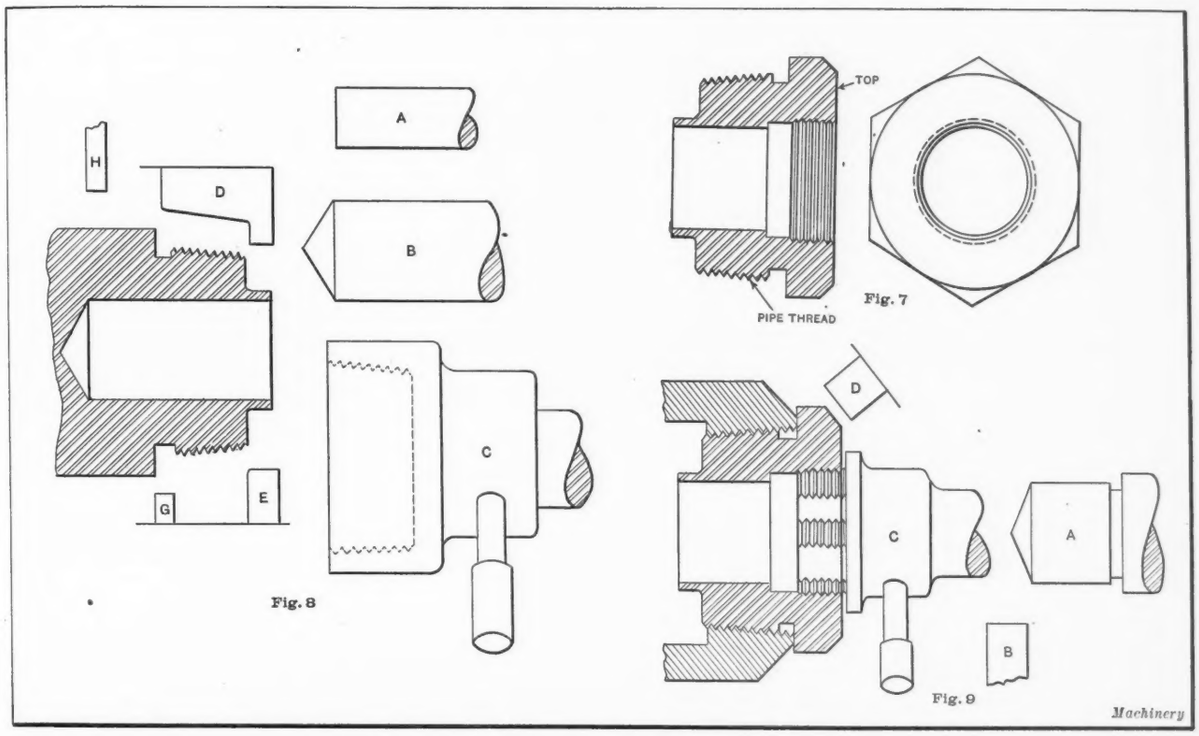


Fig. 5. Cutting Threads of High-explosive Shell Adapter with Die-head

Fig. 6. Machining Taper on Head and cutting to Length



Figs. 7 to 9. Machining Operations for the Gas Shell Adapter

WAR INDUSTRIES BOARD'S RULING ON MACHINE TOOL EXPORTS

The Machine Tool Section of the War Industries Board is calling particular attention at this time to a matter which is of great importance to machine tool builders and exporters of machine tools. The board has found that considerable equipment is being stored in New York City or other ports instead of being put into actual service.

In order to insure against financial loss and the creating of conditions which will add to the problem of readjusting our industrial line after the war, all manufacturers supplying machinery for foreign shipment should be sure that export license has been granted the War Trade Board. The license number of the machine should be obtained before it is shipped or even before production is commenced, especially if the machine is of a special design. The resolution adopted by the War Industries Board last spring and the recent plan adopted coordinating the activities of the War Trade Board are as follows, and cover each point in detail.

Exports

In accordance with the action of the board on March 26, 1918, Judge Parker submitted the following resolution discouraging the purchase of materials for export, the same to be paid for and put in storage until after the war:

"Whereas, it has come to the notice of the War Industries Board that orders have been and are being placed for the production and delivery in the United States of materials, equipment, and supplies intended for export, either actually or nominally to neutral countries, but for which no export licenses will be issued during the war; and

"Whereas, many of the products for which such orders are placed are manufactured in accordance with special designs and specifications rendering it impossible for them to be utilized to advantage or at all in this country; and

"Whereas, the said materials, equipment, and supplies are being stored for export at the termination of the war; and

"Whereas, this practice results in the utilization of materials and labor urgently needed for the production of the war requirements, direct or indirect, of the United States and the Allies;

"Now, therefore be it resolved by the War Industries Board, that the practice here mentioned is to be deprecated and should be discouraged.

"Be it further resolved that the industries of this country be requested to accept no order for the manufacture of and to make no contract of sale and to make no sale or delivery of any materials, equipment, or supplies intended for export until the proposed purchaser has first procured from the War Trade Board an export license or from the War Industries Board a permit to make such purchase."

Coordinating Activities of the War Trade Board and War Industries Board

A plan has been adopted to coordinate the activities of the War Trade Board and the War Industries Board, effective at once, as follows:

(1) The proposed exporter will now be required to make but one application and that in the form of an application for an export license to the War Trade Board.

(2) The War Trade Board will, in cooperating with the Priorities Committee and other appropriate representatives of the War Industries Board, including the Director of Steel Supply, make proper investigation and give consideration to the application.

(3) If the conclusion is reached that an export license should issue it will carry with it such priority rating as may be determined by Priorities Committee.

(4) No order for special manufacture of any article intended for export shall be placed or accepted until an export license covering same has been issued.

* * *

The War Trade Board announces that on and after November 1, 1918, all applicants for licenses to export second-hand machines or articles composed of iron or steel will be required to state that the commodity to be exported is "second-hand." Failure on the part of the applicant to describe second-hand material as such will be regarded as an inaccurate description of the goods and the applicant will be subject to the prescribed penalty therefor.

* * *

At a recent meeting of malleable casting manufacturers, held in New York City, H. J. H. Redhead, of the National Malleable Castings Co., of Cincinnati, said that the labor cost in malleable foundries is 100 per cent higher than three years ago; and that immigrant labor from northern Europe is only 80 per cent as efficient as the average American worker.

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WANTED—AN ENGINEERING STANDARDS COMMITTEE

For years, the Engineering Standards Committee of Great Britain, working under the auspices of the various national British engineering societies, has conducted a great work in creating standards for many of the important materials, machine details, and manufactured articles used in engineering. We need in the United States such a standards committee. It should be composed of members of the leading national engineering societies and should work in conjunction with the Bureau of Standards at Washington, and in close, practical cooperation with the manufacturers and the industries of the country. Subcommittees, comprising experts in special fields, should be created to take up the detail work in each field. In this way, it is likely that within a comparatively short time we could have a great many definite standards in engineering work that would facilitate production and cheapen the cost of manufactured products.

For fifteen years, the British Engineering Standards Committee has been at work and has produced acceptable standards in nearly every branch of engineering work. It is time we did the same thing here, not through a committee appointed by a society, however capable, but by establishing a large national body comprising men of recognized standing and ability, organized under the auspices of all the leading engineering societies and the Bureau of Standards—the chief government agent in work of this kind. It should not be necessary, as it is now, for Congress to pass a bill recommending that some one engineering detail be standardized. The work of standardization is of supreme importance and should be continuous and automatic; it calls for a permanent standardization committee, and the sooner we have such a committee the better.

* * *

ELIMINATING RED TAPE

It is interesting to note that the systems of munition plants have less red tape than many of the systems found in shops producing regular commercial products. This is largely due to the fact that munition plants have had a new start, and are not carrying over from the past certain systems, forms, and methods originally useful but unnecessary under present conditions. It is difficult to remove all the dead parts of a system, due to the inertia of a long-established organization, when changed conditions make them superfluous; and for that reason older organizations often carry the burden of an involved system of records and reports which can be avoided when a new organization installs an entirely new system.

Engineers who make it a business to investigate plants and recommend methods for increasing their efficiency, frequently find that elaborate card systems are being maintained and reports made out which nobody consults. Such systems were, of course, inaugurated by executives for a purpose; they did consult them and derive from them certain conclusions, but as conditions changed simpler methods were found for securing the same information. The system, however, frequently remained unchanged, and the clerks continued to file cards and make reports.

Older organizations, and particularly government departments, should profit by the experience of munition plants and eliminate, as far as possible, all superfluous clerical work. This is a good time to scan the work of every member of the organization, and to weed out all unnecessary labor.

* * *

AMERICANIZATION IN THE INDUSTRIES

As the war proceeded and constantly growing numbers of American citizens were drawn into our armies, the industrial work at home was performed in an ever-increasing degree by foreign-born men and women who had not yet become citizens of the United States. To Americanize these men and women has become an industrial as well as a political problem equally important in peace as in war. It is necessary, if the highest working intensity is to be obtained in our factories, that these men and women be inspired with American ideals, that they learn the English language, and that they become citizens with a full realization of both the privileges and the duties of citizenship.

Manufacturers can help to solve the labor problem in their own factories by aiding their foreign-born workers to become Americanized. The easiest way to approach those who are eligible for citizenship, but who have not yet availed themselves of this privilege, is through other foreign-born men who have already become citizens. The time required for taking out citizenship papers should be granted without hesitation to the men. When the foreign-born workman has been properly aided in becoming a citizen and properly taught to appreciate his adopted country, he will prove as loyal an American as the native-born. A great many of the difficulties are due to their ignorance of American conditions. No one has taken much pains to properly inform them, and most of their information has been received through agitators with axes of their own to grind. Manufacturers in industrial centers could combine to provide the proper kind of instruction. It would be well worth the cost.

* * *

HOOVERIZING ON OIL

With the enormous demands placed upon the mechanical industries during the past year, the consumption of lubricating oil has greatly increased, and it is necessary to safeguard the available supply by effecting economies in the use of oil. A great deal of oil is wasted in machine shops through the use of poorly made oil-cans and those that leak because of the hard usage to which they are subjected. In fact, a large percentage of the oil-cans used in machine shops leak around the rim or in the seam at the spout. If a machinist is asked not to waste oil, the request is not likely to make much of an impression upon him as long as the oil-cans furnished by his employers are themselves the cause of a great amount of waste. This is a small matter, but the leaks in oil-cans are only examples of the many small leaks through which a heavy percentage of the returns to both capital and labor may be disappearing.

Industrial Reconstruction for Peace

THE war is won and the invigorating tide of democracy sweeps over the world. With peace, new problems arise. The most important task ahead is the readjustment of our industries to peace conditions, involving even greater problems than their conversion to war work.

All the great nations, except the United States, have laid definite plans for "economic reconstruction." England, France, and Italy have made extensive preparations for the resumption of their peaceful economic life, with improved facilities for foreign trade.

The same kind of work must be done here, but on a greater scale, because of the magnitude of our industries and the multiplicity of our diversified interests. Bills creating a commission to guide and supervise the readjustment of our industries from a war to a peace basis are now in Congress and it is to be hoped that our lawmakers realize the profound importance of such measures. They should recognize that the men placed upon this commission must be business men and engineers of imagination and ability—men of the best type. The work of restoring our industries is not one for lawyers or politicians, but for men thoroughly familiar with the intricate details of industrial organization. A commission composed of business men and engineers of national reputation should be entrusted with the great work to be done.

With peace comes also the necessity for the Government to frame its policy in regard to the great industries now engaged in war work. It is inconceivable that the Government would, regardless of the effect, take advantage of the cancellation clauses in contracts for war materials and supplies; for such a procedure might spell disaster to many industrial concerns who have cooperated whole-heartedly in the work of winning the war. Until the industries are again on a firm peace basis, the Government must consider itself strictly responsible for the country's economic condition. Cancellations should be handled with the greatest care, and should be avoided wherever possible. Where a manufacturer has in good faith accumulated machinery, materials, and supplies for productive processes, the Government should, if possible, divert his product to useful peace purposes.

In the case of machine tools, for example, we have a typical case calling for adjustment and common sense instead of hurried and unwise cancellation of orders. While there may be many orders for machinery intended specifically for the production of war materials, there is no necessity for cancelling machine tool orders, because the Government, so long as it has control of the railroads, can advantageously absorb practically all the standard types of machine tools likely to be produced under contracts already let. The ill-equipped and run-down railroad shops need them. Sub-contractors should be given equal consideration with direct Government contractors. The wise and considerate handling of this matter by the Government is one of the most important of its duties.

Taxes must also be readjusted. While profits have been large during the past few years in many industries, heavy taxes are now taking practically all of these profits, and especially the quick assets, away from the manufacturer. This greatly weakens his ability to withstand a severe economic shock. Most manufacturers have great amounts of materials on hand, either in the rough state or partly finished, which materials may be practically worthless.

In relation to the all-important matter of foreign trade, the work of reconstruction and readjustment must be handled with breadth and vigor and intelligence. That there will be a large foreign trade in most commodities, as well as in engineering materials and machinery, no one doubts, provided the ships to carry this trade are available. There must be no let-up in the shipbuilding industry; nor will there be, with the right men at the head of our reconstruction committees.

The redistribution of labor is by no means the least of our problems of peace. Labor is now artificially distributed and unduly congested. Wages and prices are now on a war basis and must, by some gradual process, be adjusted to peace conditions. This readjustment may come in one or two ways: either by the slow and painful process of an industrial depression, or by intelligent study of future conditions and sensible adjustment to those conditions. The Government is now practically the only customer of the great industrial enterprises. There must be a gradual return to normal markets, and if this is to be accomplished without serious consequences, the change must be extended over a reasonable period of time.

War exigencies made the Government paramount and individual enterprise turned its facilities over to the nation for war work. The readjustment must come by the gradual release of the industries from Government service. Their gradual return to normal business, the redistribution of labor, the inevitable readjustment of prices, wages, and taxes, and the extension of our foreign trade, demand the wisest statesmanship and the ablest brains that can be found in industrial and commercial enterprises. We face now our greatest problems—the problems of reconstruction for peace.

PROBLEMS FACING AMERICAN MACHINE TOOL BUILDERS

BY J. B. DOAN

President, American Tool Works Co., Cincinnati, Ohio

THE problems that face American machine tool manufacturers at the present critical time are manifold, but among these there are three that appear to be of paramount importance and that might be dealt with in preference to the others, because they involve, to a great extent, the future of the machine tool building business in the United States. These problems are not all of a character to which any solution can be offered. They are conditions, rather than problems, facing the machine tool building trade. However, it is of great importance that the conditions be thoroughly understood and clearly stated, even if no specific solution can be offered that would cover every case. This is an elementary principle, because it would not be possible to offer solutions to a problem unless the conditions involved are first generally accepted.

The three problems or sets of conditions that are of the greatest importance at the present time in the machine tool building trade are these:

1. Has the production during the last few years been so great that when there is a cessation of hostilities and a gradual decrease in the production of war materials, the normal business of the country will be unable to absorb a normal output of machine tools? In other words, will the machine tools already produced meet the demands of the country for machines of this kind for some time to come? And further, what are the prospects of a heavy foreign trade?

2. If the war ends suddenly, will the Government take advantage of the clause providing for cancellation of orders that is embodied in the government contracts; and if so, what effect will this have on the machine tool trade? Will manufacturers who have ordered machine tools cancel their orders, or will they take from the machine tool builders such machines as have been ordered and which are now under way in various stages of production?

3. How will the machine tool builder meet the taxes to be paid in 1919, which are based upon the profits in 1918 if there is a general fall in prices and a decline in the business during the early part of the coming year?

Likelihood of Future Demands for Machine Tools

As regards the future demand for machine tools, opinions, of course, differ to a very great extent. The domestic demand will, of course, decrease. While it has been repeatedly stated that the machine tool requirements of Great Britain, France, Italy, Belgium, and Japan, as well as of the Scandinavian countries, would keep the American machine tool builders busy for some time to come, it is hardly possible that this trade could absorb the present large capacity of American machine tool building plants. So many manufacturers have increased their facilities and added to their capacity by new buildings and the installation of more machinery, that their normal productive capacity is far greater than immediately before the war. Doubtless there will be some foreign demand for machine tools, but this demand is not the only question to be considered. Another question is whether there will be adequate shipping facilities. The shipping board will doubtless control the classification of commodities that may be shipped overseas for some time after the war is ended, and a question that cannot now be settled is whether or not machine tools will be considered as important for immediate delivery abroad as other commodities which no doubt will also be urgently needed. It is evident that it is not possible to tell at this time what the conditions will be, but it is well to recognize the factors that are involved in future readjustments of the industry.

The Government Should Discourage Cancellations of Orders

If the war ends suddenly and the Government should begin to cancel the orders placed for war materials and machinery, and the sub-contractors in turn should also begin to cancel their orders for machine tools, a serious condition would be created, and the responsible officials of the Government should be impressed with the importance of avoiding all cancellations that would suddenly disturb the equilibrium of the industries. Nothing could be more injurious at the present time than the cancellation of orders, and the Government, as well as manufacturers who have ordered from other manufacturers, ought to recognize that the placing of an order by a buyer and the acceptance of the same by the seller, imposes an obligation on both to carry out the contract, just the same as if one were to contract for the purchase of a piece of property. When the machine tool builders are dealing with the United States Government, or with the Government's sub-contractors, they certainly may consider themselves as dealing with as honorable a body of men as exists in the world, and consequently, there should be no fear that there will be any ruthless cancellations of orders or contracts. If there ever was a time when strictly honorable conduct in business was of the greatest importance to the welfare of the nation, it is now, because it would play havoc with business of almost every nature if there were a cancellation of orders to any great extent.

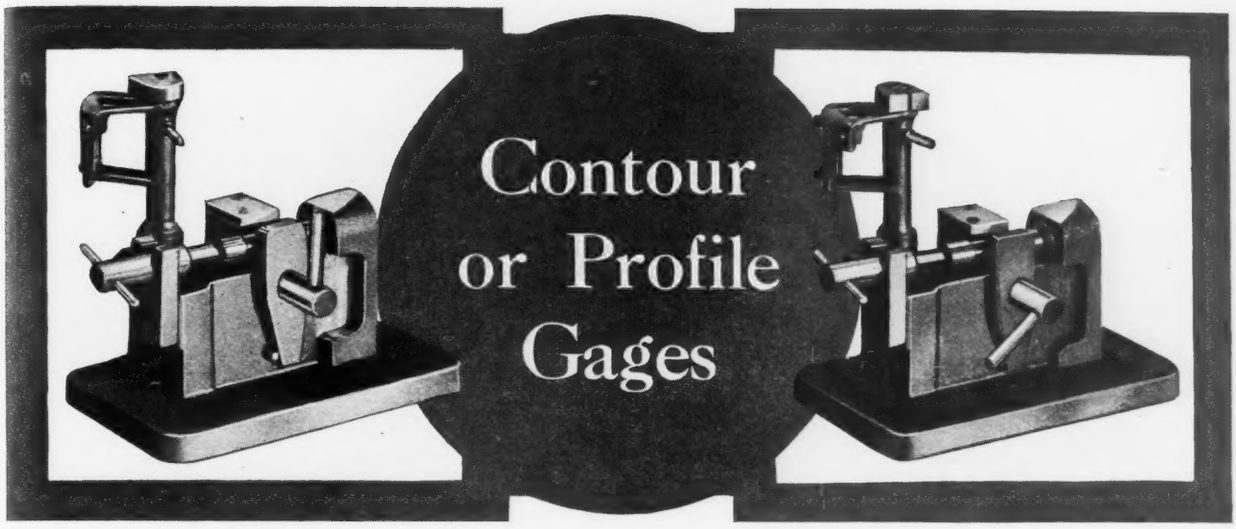
The manufacturers have on hand big stocks of materials that have been accumulated with a view to filling the orders placed with them. They have done all in their power to faithfully carry out their part of the contract. It is to be expected that the buyer will do his share with equal integrity. Not only has a great amount of material been accumulated, but upon much of this material a great deal of labor has already been expended. If orders were now cancelled, this would involve a waste of the labor that has been done upon the material at this time, when labor has been so scarce and difficulties in manufacture at times almost insurmountable.

The Question of Taxation

The taxes in 1919 are based upon the profits of 1918 and are to be paid out of these profits. Hence, at first sight, someone might say that the falling off in business during the early part of 1919 would have no particular effect upon the ability of machine tool builders to pay these taxes. To say so, however, is to ignore one of the most obvious facts in the manufacturing industry—that all profits are not on hand in ready cash. A large proportion is invested in buildings, new equipment, drawings, patterns, jigs, fixtures, and material for future production, and a good deal is represented by bills receivable. This is something that the lawmakers have not properly considered in passing drastic taxation laws. Certainly, the industries will require some readjustment in the matter of taxation, or in the method of payment, if there is a sudden decline in business, and this matter is one which manufacturers generally should place before their representatives in Congress. This problem is one to which a ready solution cannot be offered, but it is necessary that the existing conditions be recognized, because, unless there is a clear understanding of what is involved, no remedies can be proposed or devised.

Conclusion

As already stated, these are only the most important of the problems facing machine tool builders. There are numberless questions at the present time that need consideration, but many of these may be considered as sub-divisions of the three main important questions raised above, or they are of such a nature that if the questions raised above could be answered in a manner satisfactory to the machine tool building trade, these other questions would practically take care of themselves; that is, the trade, if not faced by the difficulties that result from the three conditions mentioned, could easily handle the other problems without any serious difficulty.



Third of a Series of Articles Describing Principles Involved and Procedure Followed in Developing Gaging Systems for Interchangeable Manufacture—Based upon Experience of the Pratt & Whitney Co. in Furnishing Gaging Equipment for Small Arms and Heavy Ordnance Work

BY ERIK OBERG, Editor of MACHINERY

CONTOURS or profiles are among the most difficult surfaces to gage properly, and as a rule, it is seldom possible to hold these within as small limits as diameters or length dimensions, which can be measured by plug and snap gages. However, special types of gages have been developed which make it possible to check the accuracy of curved surfaces within limits of accuracy not thought practicable a few years ago. These newer types of gages have been developed to a high degree of perfection, and involve a new principle that is not generally known to gage users.

Early Types of Contour Gages

The earliest and simplest type of contour gage is that shown in Fig. 1, where a working, inspection, and reference gage for a curved surface are shown. In a set of gages of this type the reference gage is generally made of opposite curvature to the inspection gage; that is, if the inspection gage is convex, the reference gage is concave, and vice versa. In exceptional instances, the reference gage may be made identical with the inspection gage so that, when laid on top of it, the checking of the inspection gage is made by seeing that the two gages coincide. As a rule, however, this way of making the reference gage is not as satisfactory as the method shown.

Gages of this kind are generally used by holding up the gage and the work toward the light and noting how closely the contour of the gage fits the contour of the work. The main objection to this type of gage is that it is impossible to give tolerances on the work, and the judgment of the inspector is depended upon entirely for determining whether or not the two profiles agree closely enough to meet the requirements. Hence, gages of this type are rather uncertain in their use, and are employed only where accuracy is not of

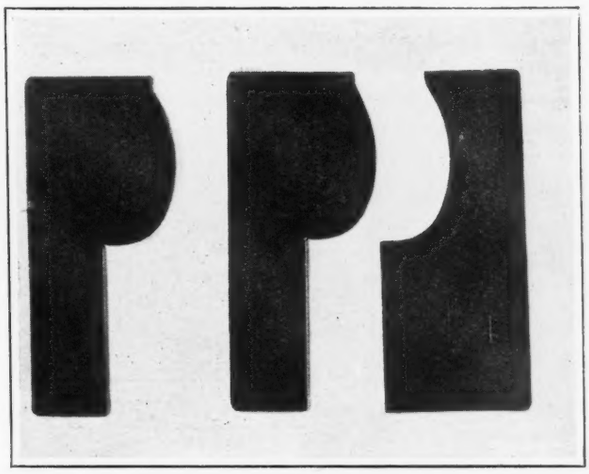


Fig. 1. Earliest and Simplest Type of Contour Gage

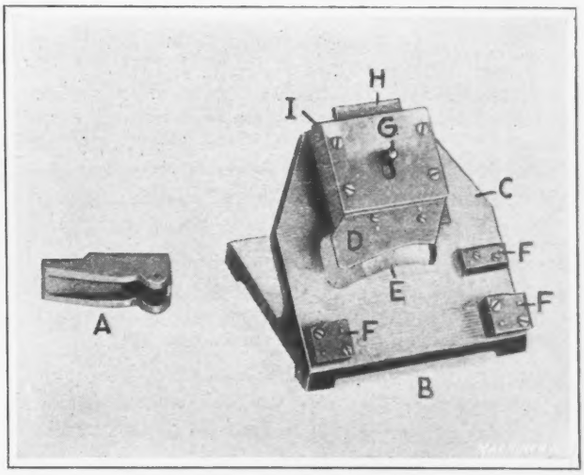


Fig. 2. Guided Contour Gage

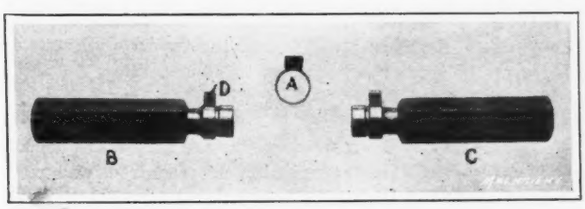


Fig. 3. Matching Type of Contour Gage

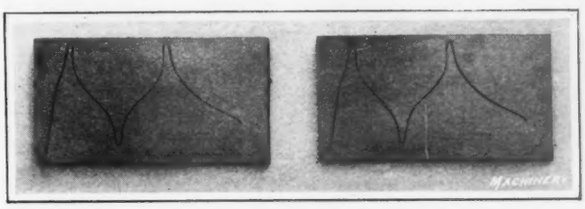


Fig. 4. Matching Gage for inspecting Shape of Spring

great importance and where the tolerances can be rather large.

As a rule, these gages are applied in such a way that a concave gage measures convex work and vice versa. Sometimes they may be used as "matching" gages; that is, the gage may be laid directly on top of the work and the two outlines matched. While it is apparent that it is impossible to provide a gage having limits when convex or concave work

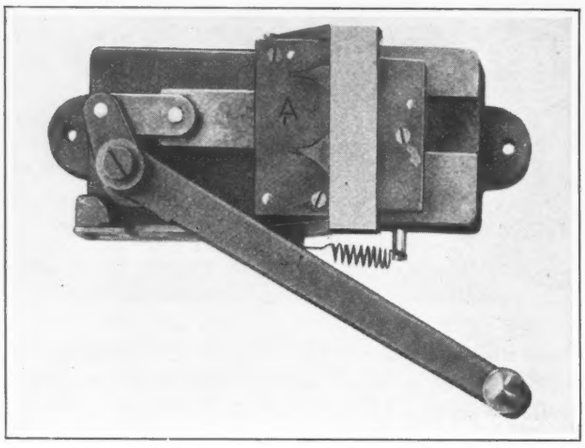


Fig. 5. Hardening Fixture for a Bent Spring

fits a concave or convex gage, respectively, it would be possible, although hardly practicable, to provide limits on a gage used as a matching gage laid on top of the work, as in that case it might be possible to provide two steps on the gage, the work being gaged by noting that no part of the work extended beyond one step nor receded below the other. Another objection to the plain templet gage is that, as a rule,

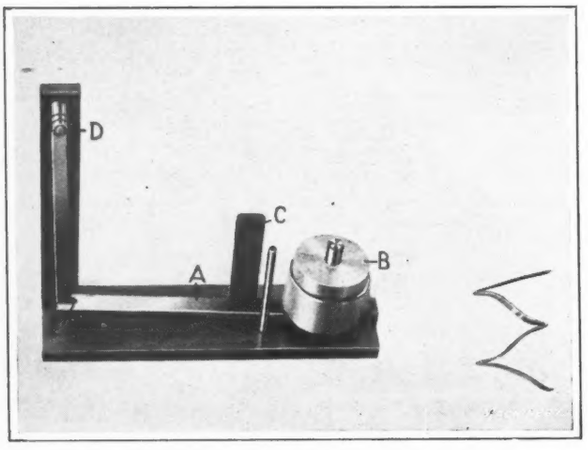


Fig. 6. Fixture for gaging or testing Strength of Spring

it does not gage the position of the contour on the work, but merely its shape. Should the contour be of the correct shape, but incorrectly located, it would seldom be practicable to provide the gage with means for indicating this.

Guided Contour Gage

In order to overcome the fault inherent in the simple contour gage of not gaging the accuracy of the position of the

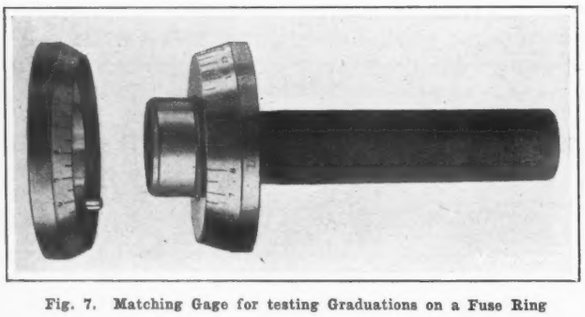


Fig. 7. Matching Gage for testing Graduations on a Fuse Ring

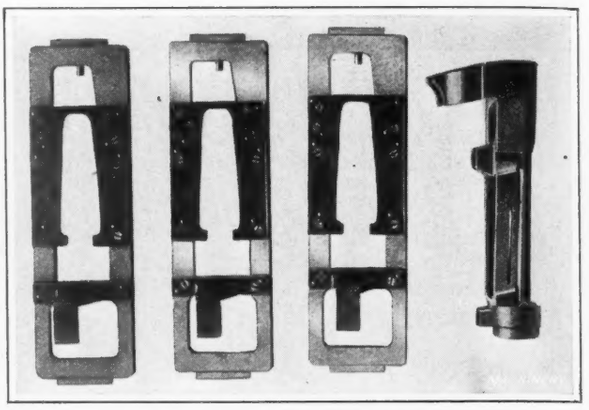


Fig. 8. Set of Matching Gages

profile, a further refinement of this type of gage provides for guides in which the contour slides so that the position of the gage is always the same with relation to a fixture in which it is mounted. Now, if the work is also mounted and properly located in this fixture, it is evident that the position as well as the shape of the contour may be correctly gaged. A device of this kind is shown in Fig. 2, where the piece to be

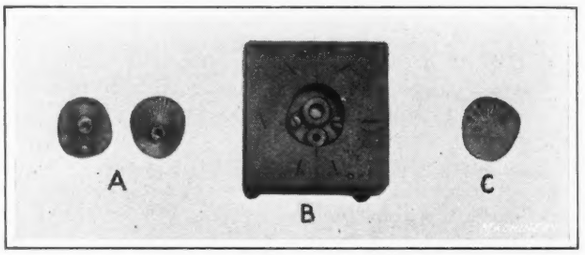


Fig. 9. Set of Typical Receiving Gages

gaged is shown at *A*, while *B* shows the gaging fixture. This fixture consists of a base block *C* upon which is mounted the profile gage *D;* the hole *E* behind the gage is provided simply so that the gage with its work may be inspected against the light to see whether the profiles match closely. The locating blocks *F* hold the piece being gaged in the proper position. Pin *G* is attached to the contour gage and slides in an elongated slot so that the gage may be moved in and out by it. This gage is also made to indicate limits of size of the piece being gaged, steps being ground on the end of the block *I*

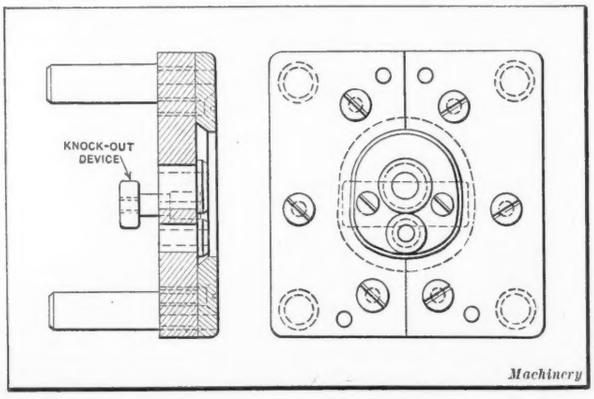


Fig. 10. Design of Working and Inspection Gages shown in Fig. 9

so that the indications may be noted in the same manner as in a flush-pin gage; in other words, the end *H* of the gage *D* must come between the two steps or shoulders on *I*.

Matching Type Contour Gages

Contour gages of the matching type are sometimes used for work where very close accuracy is not required, and where gages of this kind may be much more convenient than any other type. Fig. 3 shows an example of this kind. The work to be gaged is shown at *A*, with the working gage at *B*, and

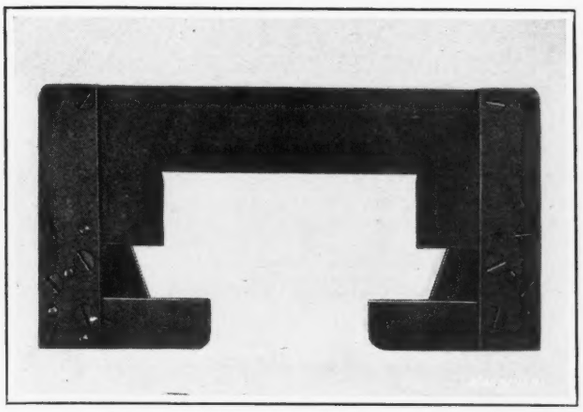


Fig. 11. Receiving Gage of the Built-up Type

the inspection gage at *C*. To gage the work it is merely slipped onto the plug on the end of the gage and the projection on the work is matched with the projection *D* on the gage, the judgment of the workman and the inspector being depended upon to determine that the work is nearly enough like the gage in shape and dimensions to answer the requirements.

Another type of matching gage is shown in Fig. 4, which is used for inspecting the shape of a spring made from flat

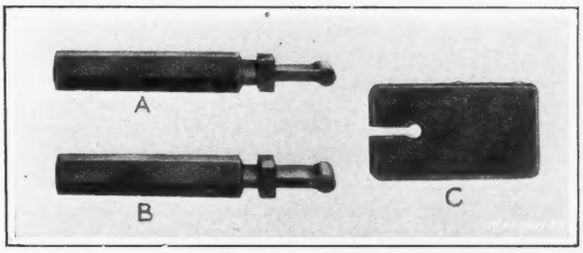


Fig. 12. Receiving Gages for Work shown in Fig. 13

spring steel, and bent to the outline shown in the illustration. The spring is shown to the right in Fig. 6. The lines on the face of the gage (both the working and inspection gages are shown in Fig. 4) are etched into the surface of the gage-plate; or shallow grooves may be cut if desired with a small end-mill. The spring is then matched up with this shallow groove to determine whether it is of the right shape or not.

Incidentally, it may be of interest to show the fixture used when hardening this spring. This fixture is shown in Fig 5, and is employed to give the proper shape to the spring. The

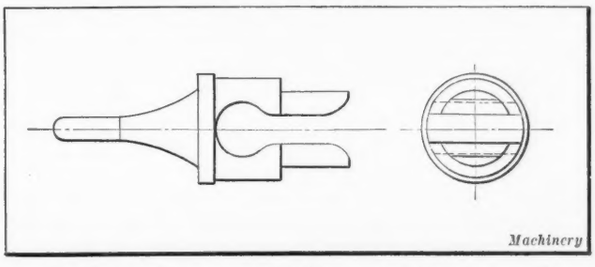


Fig. 13. Work for which Receiving Gages in Fig. 12 are used

spring, after having been shaped to the required outline, is heated to the hardening temperature, and is then clamped in the hardening fixture, in which it is cooled by contact with the jaws. In this way it is possible to retain the required shape. The jaw *A* of the fixture is movable by means of the handle and lever arrangement shown, so that the spring may be placed into this jaw when in the outer position and then pressed against the inside jaw for cooling.

An interesting fixture is also used for gaging or testing the strength of this spring, this fixture being shown in Fig. 6, where the completed spring is also shown. The spring is placed under the lever *A* on the end of which weights are placed at *B*. On the upright *C* are two lines. When the spring is placed in the testing fixture, the use of the two weights shown at *B* should bring the lever *A* down so that its upper surface coincides with the lower line on the upright *C;* then, when the upper weight *B* is removed, the spring should raise the lever so that its upper surface coincides with the upper line on the upright. An important feature of the fixture is the use of the swinging joints at *D* and *E*, which produce as free a movement as possible, so that

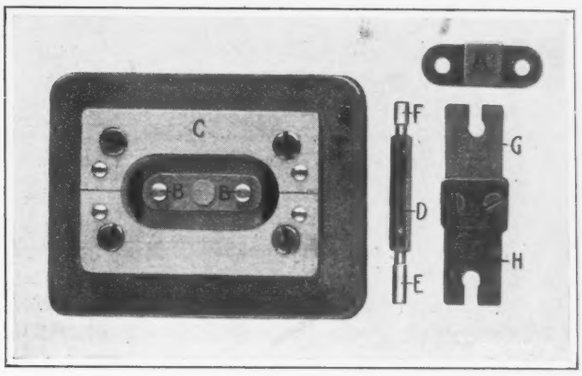


Fig. 14. Improved Type of Receiving Gage making Use of Maximum and Minimum Plug Gages

the spring is able to take its natural position while being tested.

Another example of a matching gage is shown in Fig. 7. This is used for testing the graduations on a fuse ring by comparison with the graduations on the gage. In a case of this kind, a reference gage is hardly necessary, except that it may be kept as a record in case the inspection gage should become lost. It is evident that an inspection of this kind

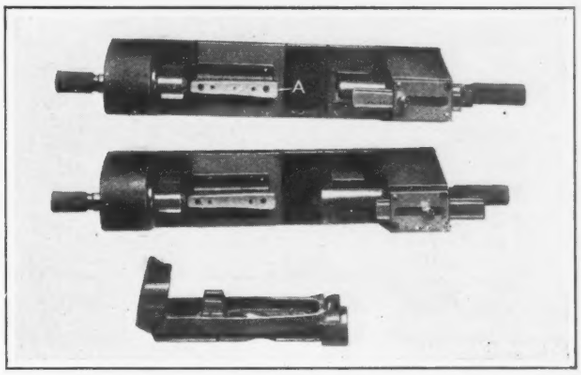


Fig. 15. Another Application of the Principle of the Receiving Gage using Maximum and Minimum Plugs

needs no further checking after it has once been approved, as the graduations cannot wear in the sense that a snap gage or plug gage might wear.

Fig. 8 shows a matching gage used for gaging a contour on the work shown to the right. The complete set of receiving gages—one working, two inspection, and one reference gage —is shown. In this case the reference gage is shown to the extreme right and is made of the same shape as the piece to

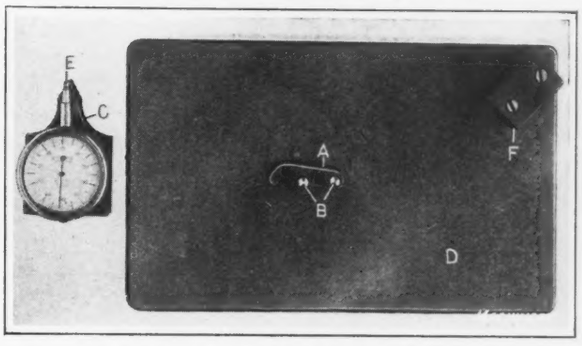


Fig. 16. Simple Type of Dial Indicator Contour Gage

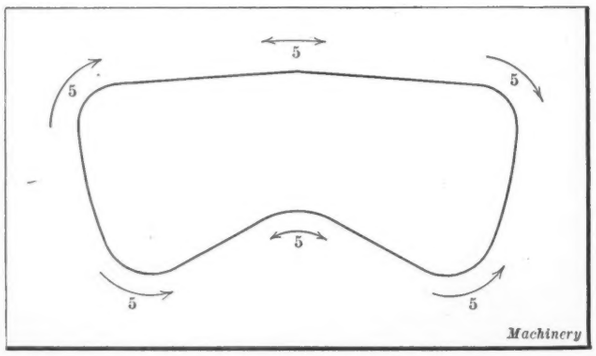


Fig. 17. Method of stamping or marking Tolerance on Dial Contour Gages

be gaged. The testing of the inspection gages is made by matching the gages.

Receiving Gages

The simplest type of receiving gage consists simply of a flat templet in which a hole or opening is cut, corresponding to the shape of the work; the work is then fitted into this opening to determine whether it is of the required dimensions. Receiving gages can, of course, be made to act as limit gages, as two gages may be used, the work passing through

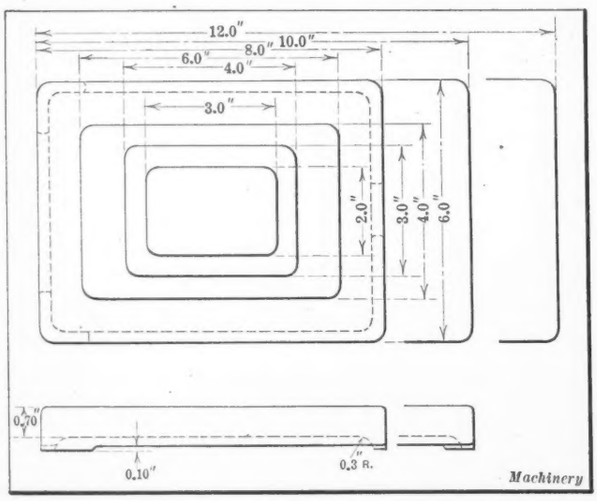


Fig. 18. Standard Baseplates for Gaging Fixtures—Small Sizes

one and not through the other. However, this is a rather unsatisfactory method of gaging, as there is nothing to indicate at what point the work is incorrect, in case it should not pass through the maximum gage, and furthermore, it is possible that the work will pass through one gage and not through the other, and yet be defective; because the gage will be expected to measure or gage so many different dimensions on the work that satisfactory gaging of very accurate work in this way is impossible. As a rule, the simple templet receiving gage is merely used to pass over the work with a view to seeing that it corresponds approximately to the shape of the gage, and the judgment of the inspector is depended upon the same as in the case of the plain templet contour gage.

In Fig. 9 at *B* is shown a receiving gage which is typical of this class of gages. The work is shown at *A* and a reference gage is shown at *C*. The work is located in the gage by the two projecting stems which fit into the bushings in the gage. The complete set of gages for the work shown at *A* consists of working and inspection gages, like the one shown at *B*, and one reference gage, as shown at *C*. The design of

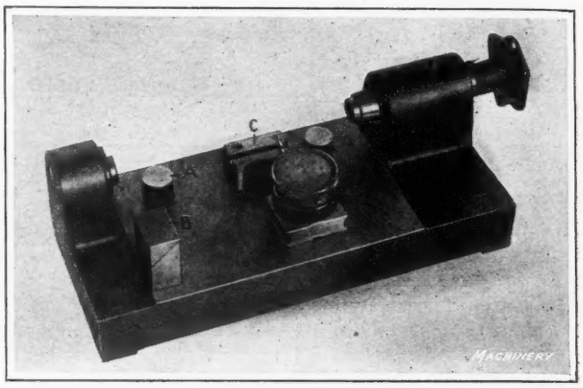


Fig. 20. Type of Dial Indicator Contour Gage

the working and inspection gages is more clearly illustrated in Fig. 10. Another example of receiving gages is shown in Fig. 12, and the work for which they are used may be seen in Fig. 13. The working gage is shown in Fig. 12 at *A*, the inspection gage at *B*, and the reference gage at *C*. Some times receiving gages may be made of the built-up type as in Fig. 11, which shows a gage for a round piece of work, turned partly to a taper, and made in five different parts held together by binding strips, screws, and dowels. This method of making the gage, of course, is used simply to make it possible to grind the gaging surfaces.

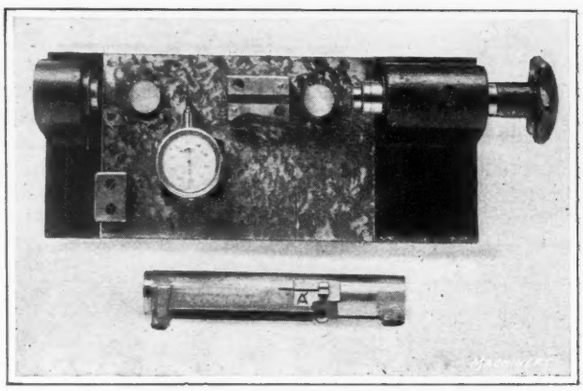


Fig. 21. Same Gage as shown in Fig. 20 seen directly from above

Improved Form of Receiving Gage

Fig. 14 shows an improved type of receiving gage which makes it possible to gage work made within prescribed limits, and which also makes it practicable to determine exactly where an error is located in the contour in case the work is not within the required limits. The work to be gaged in this case is of the shape shown at *A*. It is placed in the opening in the center of the gage and is located by the studs *B* passing through the holes in the work. The outside of the work, however, does not fit the oblong hole in the gage-plate *C* closely, but there is a space between the outside of the work and the inside of the hole, this space, when the piece is correctly made, being of practically uniform width all around the piece. The maximum and minimum plug gage *D* is then used to determine whether the required tolerance has been observed in making the piece. The minimum plug *E* must

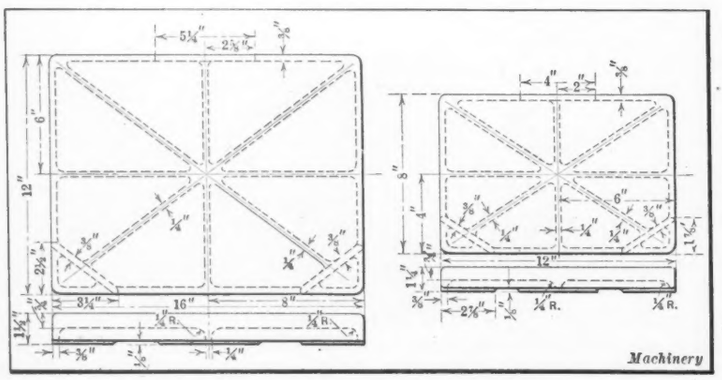


Fig. 19. Standard Baseplates for Gaging Fixtures—Large Sizes

pass in the opening between the outside of the work and the inside of the hole in the gage all around the work, while the maximum plug *F* must not enter this slot at any point. If it enters, it is evident that the work is too small at the point where it enters. On the other hand, if the minimum plug *E* cannot pass clear around the work, it is evident that the work is too large at the point where the minimum plug cannot pass by. The snap gages shown at *G* and *H* are the reference gages for the plug gages.

As compared with the simple receiving gage, this gage has the advantage that it shows where the error is located, and indicates to a certain degree the amount of the error. It also gages the position of the contour with reference to the locating point. The ordinary plain receiving gage generally is understood to require an exact fit, and should not be used except when the component part is required to have a corresponding fit in its mating part. However, when an exact fit is required, the plain receiving gage may be of advantage, as it then insures that the part really will fit its component part in the mechanism for which it is to be used. If limits are required at some points, additional snap gages may sometimes be used at those points. In most instances, however, the receiving gage using maximum and minimum plugs as shown in Fig. 14, is superior to the plain receiving gage that does not indicate both limits. In gages of the type shown in Fig. 14, ball points instead of cylindrical plugs are sometimes used. The maximum and minimum testing-plug type of receiving gage is sometimes found necessary to use when other means of gaging are impracticable.

The principle of the receiving gage using maximum and minimum plugs may also be applied for the gaging of the contours of holes, as indicated in Fig. 15, where the gage for testing the cartridge opening in a rifle receiver is illustrated. The determining shape in the gage is shown at *A*, the receiver being slipped over this shape and the opening of the hole in the receiver being inspected by passing a maximum and minimum plug around the shape *A*, and between it and the inside of the opening to be gaged. The rifle receiver is held in the gage by plugs at both ends and means are also provided for holding it in position so that it cannot rotate or move while being gaged.

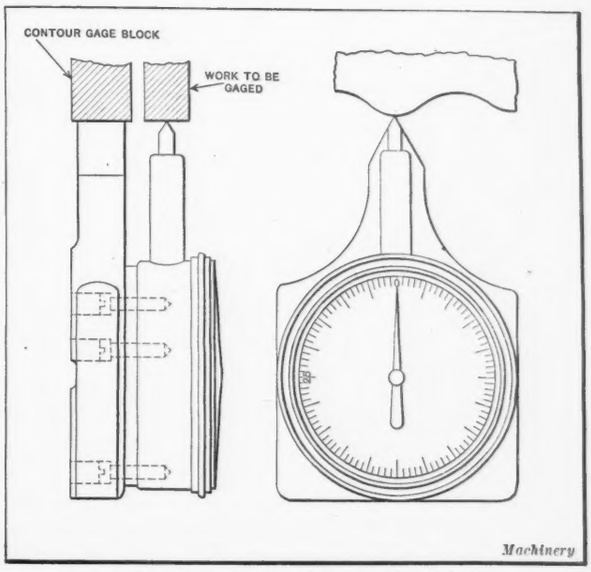


Fig. 23. Base Block used for mounting Dial Gage

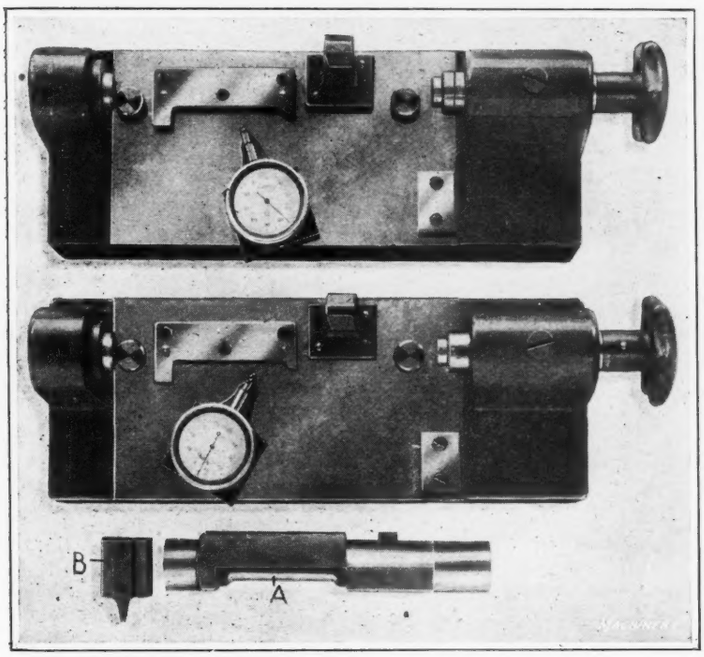


Fig. 22. Dial Indicator Contour Gage for a Rifle Receiver

Dial Indicator Contour Gages

The highest development in the gaging of formed surfaces is doubtless the dial indicator contour gage, the elements of which are shown in Fig. 16, and a brief explanation of the principles of action of which follows. This type of gage consists in its simplest form of a baseplate, which has mounted on it means for holding the piece to be gaged as well as the master form with which the piece being gaged is compared. In Fig. 16 this form is shown at *A*, the piece to be gaged being of exactly the same shape and having two holes by means of which it is located over studs *B*. A dial indicator mounted on a baseplate *C* of its own, slides on the baseplate *D* of the gaging fixture in such a way that the point on the indicator baseplate *C* is in contact with the form *A*, while the point of the indicator itself is in contact with the work to be gaged. It is important, of course, that the point of the indicator be exactly above and coincident with the point *E* of its base. At *F* is shown a setting block, used for setting the dial to read zero. This block is high enough so that when the base block of the dial with the dial mounted on it, is brought against the setting block, both the point of the base block and the

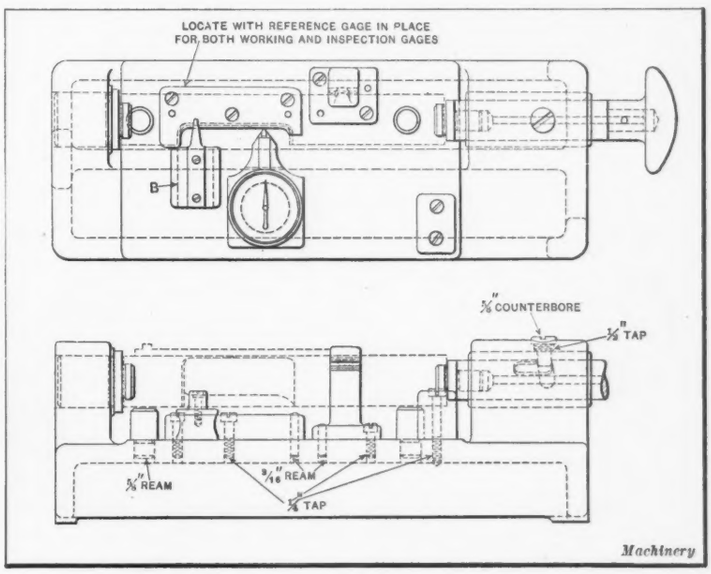


Fig. 24. Design of Dial Contour Indicator Gage shown in Fig. 22

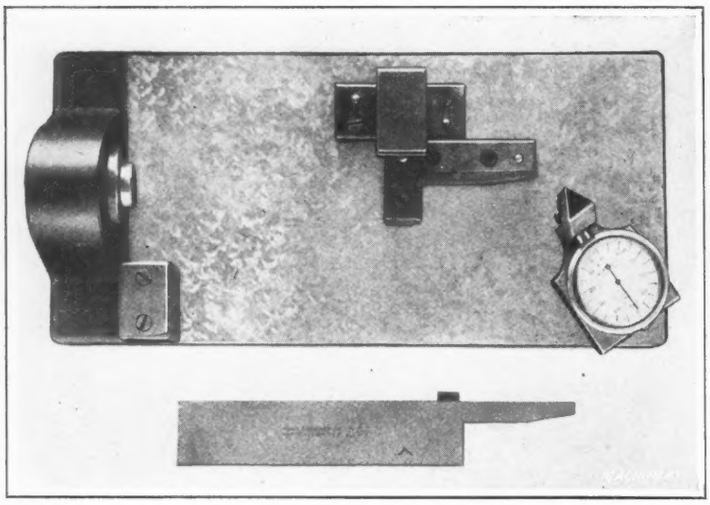


Fig. 25. Dial Indicator Contour Gage in which Indicator Pointer bears against the Master Form

pointer of the dial indicator bear against the block. Hence, the dial can be set to read zero when the two points coincide before beginning gaging.

The advantages of the dial indicator contour gage are numerous. In the first place, this type of gage makes it possible to determine quickly and accurately whether the work is within the prescribed limits or not, as the variations of the indicator hand will show the deviations; the gage is easy to use and apply; and the tolerances or limits may be varied at different points along the contour, as the indicator will show the different limits on its dial at any point. The usual practice is to stamp the tolerances on the baseplate opposite the part of the contour that should be made with a certain tolerance. Not only is the gage simple in its application, but it is also comparatively inexpensive to make, when made from standard parts, as is the usual practice. The dial indicator itself is a commercial product, and the only expensive part is the master form *A*, but as this form would be expensive for any contour gage, it will not increase the cost of this type as compared with other gages.

The wear of a gage is small, because the master form is in contact only with the smooth hardened point of the block on which the dial is mounted, and is not subjected to the grinding wear to which an ordinary contour gage is exposed—when pieces of work are constantly passed through it. The gage is also well adapted for the adjustment of machines and tools when setting up work, because it indicates the exact amount of error, and hence the amount of adjustment required. In some instances there are no other means practicable for gaging work, as for example, for slots cut into a piece of work and having a bottom that is not flat but shaped to a contour. In that case the only accurate means of gaging is by an indicator point that can reach into the bottom of the slot and follow it while the point of the baseplate underneath the dial follows a similarly shaped contour on the gaging fixture.

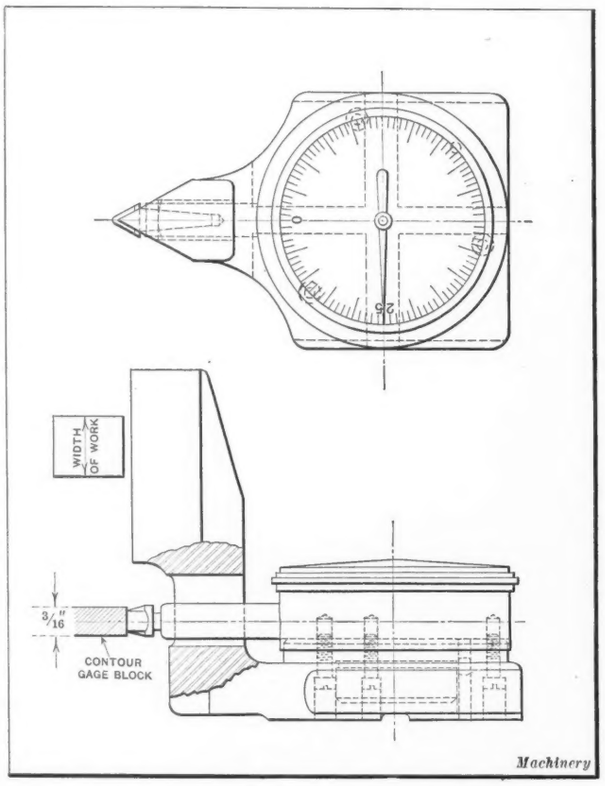


Fig. 26. Construction of Baseplate for Dial Gage shown in Fig. 25

As already mentioned, the point of the indicator gage and the point of the base block on which it is mounted, must be exactly in line and of exactly the same shape, so that no error can be introduced in case the base block is not held squarely against the surface being gaged. The two points are therefore lapped together against a lapping block. The only requirement for accuracy on the part of the setting block *F* is that its setting surface is square with the top of the plate *D* on which the base block *C* of the indicator slides.

Fig. 17 shows the method of stamping or marking the tolerances for a contour that is made to variable limits. The arrow-heads indicate the direction in which the indicator needle should swing from the zero position. The figure beneath the arrow-head gives the tolerance in thousandths of an inch. Thus, for example, an arrow-head with the figure 5 beneath it indicates a tolerance of 0.005 inch. The direction of the arrow-head indicates whether the tolerance is + or —. If there are arrows pointing in both directions, as also shown in Fig. 17, this indicates that the tolerance is, in the case shown, ± 0.005 inch. The arrows and figures are stamped on the baseplate of the fixture, opposite the respective parts of the contour form.

Figs. 18 and 19 show standard designs of baseplates for gaging fixtures as made by the Pratt & Whitney Co. These plates are made from cast iron and the smaller sizes are practically solid except that they are relieved on the bottom side. Fig. 18 shows standard sizes varying from 2 by 3 inches to 6 by 12 inches. When the dimensions are larger, the design shown in Fig. 19 is followed. These are ribbed plates, having dimensions 8 by 12 inches and 12 by 16 inches, respectively.

Fig. 23 shows a drawing of the standard base block used for mounting the dial gage. These baseplates are made in different types according to the kind of work that is being gaged. It is evident that the point of the dial gage may have to be raised higher or be held at a lower level, according to the character of the piece to be tested; hence the construction shown.

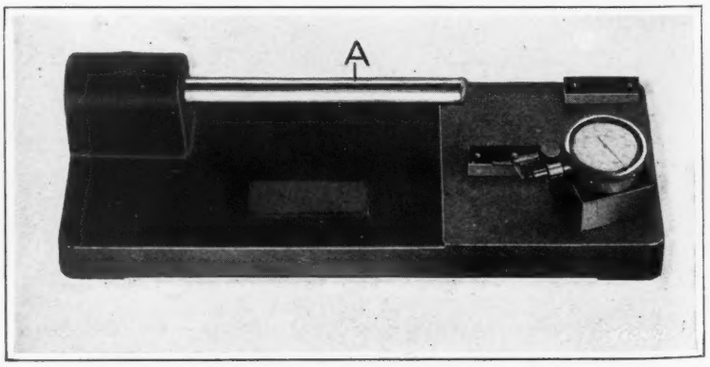


Fig. 27. Indicator Dial Contour Gage used for gaging the Concentricity and Diameter of an Internal Recess

Examples of Dial Indicator Contour Gages

Fig. 20 shows a dial indicator contour gage in the working position and the kind of fixture that often is required in connection with it, provided with holding and locating means for the work to be gaged. In this case the shaped bottom of a slot is to be tested, the work being held on the cylindrical plugs at the ends and resting upon and being located by the two plugs *A* in the baseplate of the fixture. The setting block is shown at *B*, and the master contour form at *C*.

Fig. 21 shows the same gage directly from the top and the rifle receiver that is gaged in it. The slot, the bottom of which is gaged, is indicated at *A*. As this slot is very narrow, the movable point on the indicator gage is flattened so that it will enter the slot.

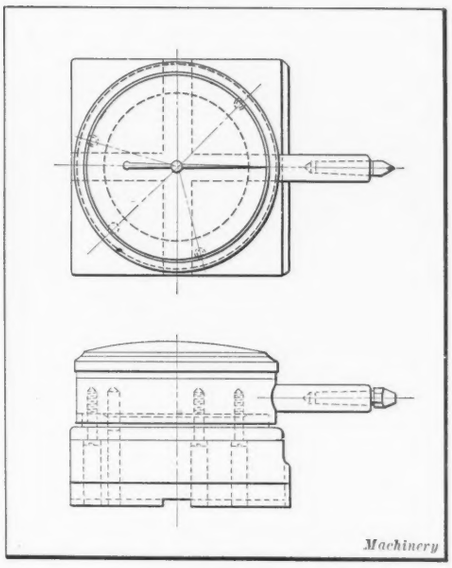


Fig. 28. Construction of Base Block for Indicator Dial used in the Gaging Fixture shown in Fig. 27

Fig. 22 shows another gage of the same kind, which is used for gaging the contour at *A* in a rifle receiver. A line engraving showing the details of the construction of this gage is shown in Fig. 24. The contour at *A*, Fig. 22, is also curved in a vertical direction, and this vertical contour is tested by the gage *B* shown at the end of the receiver; this gage is shown in place for gaging on the fixture in Fig. 24. This auxiliary gage does not actually gage the contour of the receiver, but it locates it in the proper position so that the indicator gage will ride along the contour at the proper height or along the proper line of the work.

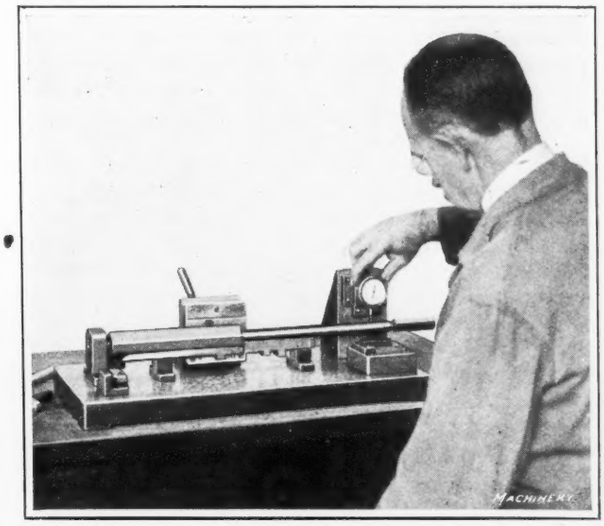


Fig. 29. Application of a Guided Dial Gage used for gaging in the Vertical Position

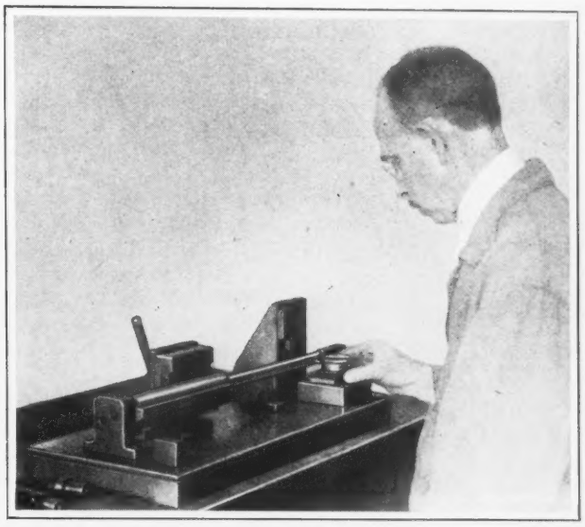


Fig. 30. Same Fixture as in Fig. 29 being used for gaging in the Horizontal Position

A Special Application of the Dial Indicator Contour Gage

Fig. 25 shows a special application of the dial contour gage. This construction is required when the surface to be gaged is not in one horizontal plane, so that the gage point could not follow the outline as it moves in a horizontal plane. In that case the position of the indicator pointer and the point on the base block upon which the indicator is mounted, are reversed. The base is provided with a projection extending upward, so that the point of the base can bear against the work, while the movable indicator point bears below against the master form.

Fig. 26 shows the construction of the baseplate for the dial gage when used in this manner, and also indicates its application to the work and to the contour form. This type of construction greatly increases the range of work to which this gage may be applied.

When the principle upon which the dial indicator contour gage is understood, it is evident that it is not limited to the gaging of contours, but it may be also used for the gaging of steps, recesses, and other cases where it may often be simpler and cheaper than a great number of snap gages would be.

Fig. 27 shows a special case in which a gage of this type is used for indicating the concentricity of an internal recess of a cylindrical piece, as well as its diameter. In this case the base is pushed against a flat locating surface and hence has no pointer. A bellcrank arrangement, mounted on the indicator point as shown, makes it possible to reach into the inside of the work to be gaged, which while gaging, is held upon the arbor *A*. Fig. 28 shows the construction of the base block for the indicator dial, together with the dial pointer, but does not show the bellcrank attachment.

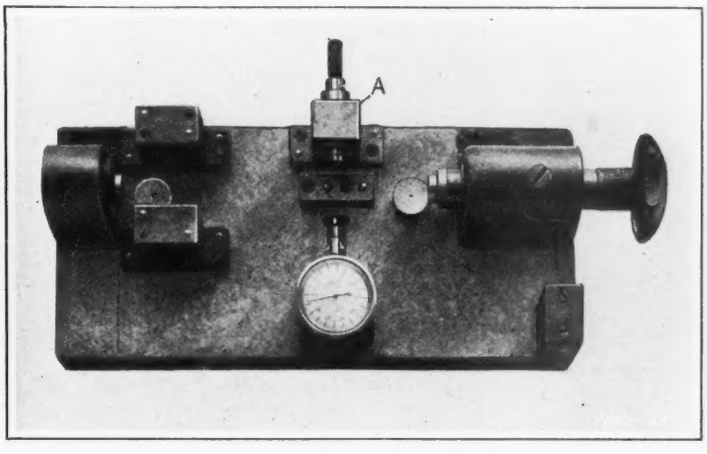


Fig. 31. Guided Dial Contour Gage used for gaging the Depth of a Slot

Fig. 31 shows a special type of dial con-

tour gage which is only used for gaging the depth of a slot. Hence, the base upon which the dial gage is mounted is guided as indicated. The pin *A* gages the location of the slot, the depth of which is measured by the dial. The work is mounted on the plugs at the ends, so that it can be turned around into two positions for gaging first the location and then the depth of the slot.

Figs. 29 and 30 show the application and use of a guided dial gage which is used for testing in both a vertical and a horizontal position. It will be noted that the gage is first applied in the vertical position, sliding down along a guide so that it will be held exactly vertical, and is then applied horizontally in the same manner.

* * *

DIE-CASTING OF ALUMINUM BRONZE[1]

RESULTS OBTAINED BY THE ADDITION OF IRON AND MANGANESE TO COPPER

BY H. REX AND H. WHITAKER

Die-castings may be defined as finished castings made by pouring molten metal, flowing by gravity or under other external pressure, into a metallic mold. Some of the advantages of die-casting are: Accuracy and uniformity of the castings, which can be made to within 0.005 inch, or even less for small parts, and greatly reduced machining costs, which may be eliminated altogether. The process is continuous, and the output generally is much greater than with sand-casting. Articles impossible to sand-cast may be successfully die-cast.

Classes of Die-casting Metals

The alloys employed may be divided into five classes, according to whether the principal constituent is zinc, tin, lead, aluminum, or copper. Owing to their low melting points, at first alloys of the first three classes were employed, but the castings lacked strength and rigidity. An average zinc-base alloy has a tensile strength of about eight tons per square inch with practically no ductility, but these alloys are liable to corrosion and distortion. The tin- and lead-base alloys include a large number of the babbitt or bearing-metal type, and many bearings are now being die-cast.

The low specific gravity, cheapness, and strength, when alloyed, of aluminum have been the principal factors in its development as a die-casting metal. Its chief drawbacks are its high melting point, compared with lead, tin, and zinc; its tendency to attack iron when molten; its high shrinkage; and its weakness at high temperatures. A die using zinc-base alloys lasts almost indefinitely, but when using aluminum alloys cracks begin to show in the die after 2000 or 3000 castings have been made. The high shrinkage of aluminum has been reduced by alloying, and need not exceed about 1.4 per cent. The weakness of the alloys at high temperatures is responsible for the formation of cracks, which develop while the metal is solidifying in the mold. Thus the strength of the copper-aluminum alloy containing 12 per cent copper drops from eight to ten tons per square inch at 0 degrees C. to three to five tons at 350 degrees C. Notwithstanding these drawbacks, aluminum alloys of variable composition are being successfully die-cast on a large scale.

Difficulties with Yellow Metals

The chief difficulty involving the use of yellow metal is the high temperature at which it is melted, namely, 900 to 1000 degrees C. The zinc in the brass attacks the steel die, which rapidly deteriorates, so that no more than 1000 castings can be obtained. The high shrinkage of brass sets up stresses within the die which further impair its accuracy; since the die cost is the prime factor in die-casting, this is a serious problem. It is impracticable to use an iron container for the molten metal, as the alloy would rapidly become contaminated thereby; hence, air pressure cannot be employed to force the metal into the die. This means pouring from crucibles, with consequent slowing down of production, if only one die can be used. Another consequence of the high temperature and slow pouring is the large amount of dross formed. Ordinary brasses are not sufficiently strong at high temperatures to withstand the shrinkage stresses. It is difficult to produce brass die-castings that are consistently free from blow-holes or shrink-holes. The former are caused by air being entrapped in the mold, and they cannot be overcome by simply increasing the pressure in the mold or by carrying out the process in a vacuum. By a careful study of the venting and gating of each part, however, this unsoundness may be practically eliminated.

Brass and bronze die-castings are a commercial success only if the parts cannot be completely produced by automatic machinery or when numerous difficult machining operations, involving different settings of tools, are obviated. To compete with the machined products, the die-castings must be rapidly made, must be accurate to within $\pm$ 0.002 inch, and must have a smooth, polished surface. Recent developments in foundry and machine shop practice have made it possible for many parts to be more cheaply sand-cast, and yellow metal die-casting is practically restricted to pieces of fairly simple shape, weighing between one-half ounce and three pounds.

Experiments with Aluminum Bronze

The experiences of the authors in this connection have been chiefly in the use of brass (60 : 40) containing about 2 per cent aluminum and with manganese brass and aluminum bronze containing iron. In the first case, the aluminum is added to give fluidity to the metal and better definition to the castings. In the second case, manganese brass of usual composition is used, containing less than one per cent manganese with a little iron and aluminum. The chief objection to these metals is that the surface of the die becomes rapidly covered with a coating of zinc oxide, which must be brushed off after every cast or the definition is spoiled. Various methods have been tried to overcome this difficulty, but so far without complete success. The best results have been obtained with aluminum bronze containing iron. The first alloys experimented with were of copper-aluminum containing about 10 per cent aluminum, the remainder being copper. The results were disappointing, as the metal did not lie quietly on the surface of the die and the definition of the edges was poor. The addition of a little iron produced much better results.

Iron and manganese, when added to copper-aluminum alloys containing 7 to 10 per cent aluminum, raise the yield point and ultimate tensile strength at the expense of the ductility.

In the case of sand-cast bars, the addition of iron appears to give better all-around mechanical properties than the addition of an equal amount of manganese. The data are not available for a complete comparison of the chill cast bars, but some promising results have been obtained by the authors with alloys containing 7 to 10 per cent aluminum and 1 to 4 per cent iron. In the commercial production of die-castings in one of these alloys, the following average results were recently obtained from twenty-four test-bars, cast in a 1-inch chill and cooled in air: Diameter of test section, 0.564 inch; yield point, 14.7 tons per square inch; ultimate tensile strength, 35.5 tons per square inch; elongation in 2 inches, 24 per cent; and reduction of area, 21.8 per cent. Each bar represents a batch of castings produced consecutively during a period of several months, under ordinary foundry conditions.

The mechanical properties of the copper-aluminum-iron alloys may be profoundly modified by heat-treatment, and this probably accounts for the variable results obtained with the same metal under ordinary casting conditions. Consequently, accurate pyrometric control of the die-casting process is advisable, if consistent results are required. The temperature of the molten metal and of the die should be known, and the rate of cooling of the hot casting should be standardized. Many different mechanical properties would result

[1]Abstract of a paper presented to the Institute of Metals, London, England.

if, instead of quenching the casting red-hot from the chill in cold water, it were allowed to cool slowly in air. An advantage of the alloy used by the authors is that it is sufficiently fluid to fill the die and to give satisfactory castings through a wide range of temperature.

Material for Dies

Several materials have been experimented with—ferrous and non-ferrous—for die-making, but the best results have been obtained with a close-grained iron that is as hard as is consistent with good machining properties. The block of iron from which the die is made is itself chill cast to give these qualities. Sometimes the dies have been cast almost to shape before machining, but the results have not been very satisfactory. It need not be pointed out that a die is only suitable for one particular alloy. Each alloy has its own requirements regarding gating, venting, and shrinkage, and the particular problems of each new part render it difficult to make a correctly designed die at the first attempt. The design of the die is a most important factor, and it is here that experience is the best guide. The part should be designed to conform to the special requirements of die-casting, and there is need for the closest cooperation between the engineer, metallurgist, and foundry foreman. The number and shape of the parts of the die, method and order of withdrawing the cores, venting, location, shape and size of the gate must be carefully considered in designing a die.

Cost of Process

No general rule can be laid down with regard to costs. In some cases die-casting is cheaper and in other cases more costly than sand casting. The cost of dies, material, labor, and machining must be investigated before a decision can be reached as to which is the more economical process. The cost of machining and assembling a carbon brush-holder of the butterfly type is eight times as great when sand-cast as it is when die-cast. The castings are not sold by weight, as the cost of labor varies in making the dies and the castings. The die cost is treated as a separate item from that of the castings, and is generally borne directly by the customers.

* * *

RECEIVING AND MAINTAINING STOCK OF RAW MATERIAL FOR THE FACTORY

BY H. H. ARMSTRONG

One of the great difficulties in many manufacturing plants is the lack of a system for obtaining raw material in time to meet the production requirements. It often happens that the design of a certain mechanism or apparatus is completed, the drawings made, and the tools finished, although the apparatus itself is slow in coming through the factory. Investigation generally shows that the raw material for this work is lacking. The reason for this shortage of material can usually be traced to several sources, but chiefly to the fact that a "material list" was not made up so that the material could be ordered in advance.

The "material list" is a sheet designed to cover all the material required for the particular piece of apparatus, and generally covers the number of pieces of the requisition, no matter what the quantity may be. It is necessary that this sheet be in the hands of the order department at the earliest possible moment, so that while the tools and patterns are being made, an opportunity is given to have the raw materials delivered. The material list compiler should be a man of broad factory experience, for when the drawings are received by him he should be capable of telling exactly what departments of the factory will perform the work, and compile his list accordingly. For instance, he finds a drawn piece made of steel and he knows that the material list should specify the width of stock. He therefore goes to the tool department and ascertains the size of the blank required. The tool department will also note this width, so that when the die is completed, the opening will be large enough to take this width of stock. The same rule applies to spinnings and also to sheet metal work made by templets. There is no excuse for shearing stock to fit the dies when this information has been looked up in advance by a careful and thorough material list writer. If material is ordered in multiples of the length of the blank, short ends may be eliminated, and this is a matter of economical importance especially where sheet copper and brass are concerned. In addition, much time and expense may be saved by checking all material for tools with the tool department before ordering, so that, when the material arrives, the die openings will take this predetermined width.

Castings for the device will also be listed on the material list and the list writer will figure the weights and record in a separate column the total weight of iron or alloy required. When these items come to the attention of the foundry, the required requisitions will be made, and when the order for the castings reaches them, the material will be on hand. The vital object of the material list is to keep production running continually and also to bring all parts for the apparatus about simultaneously to the final stock-room, where the finished pieces may be assembled for shipment. It is poor management to order a foreman to assemble a certain mechanism, if on arriving at the stock-room he is only to find that there is no material. Screw machine parts are essential to most devices. By interviewing the screw machine foreman, the material list writer is able to specify a grade of material that will give the best results in the machines, and thus oftentimes hasten production.

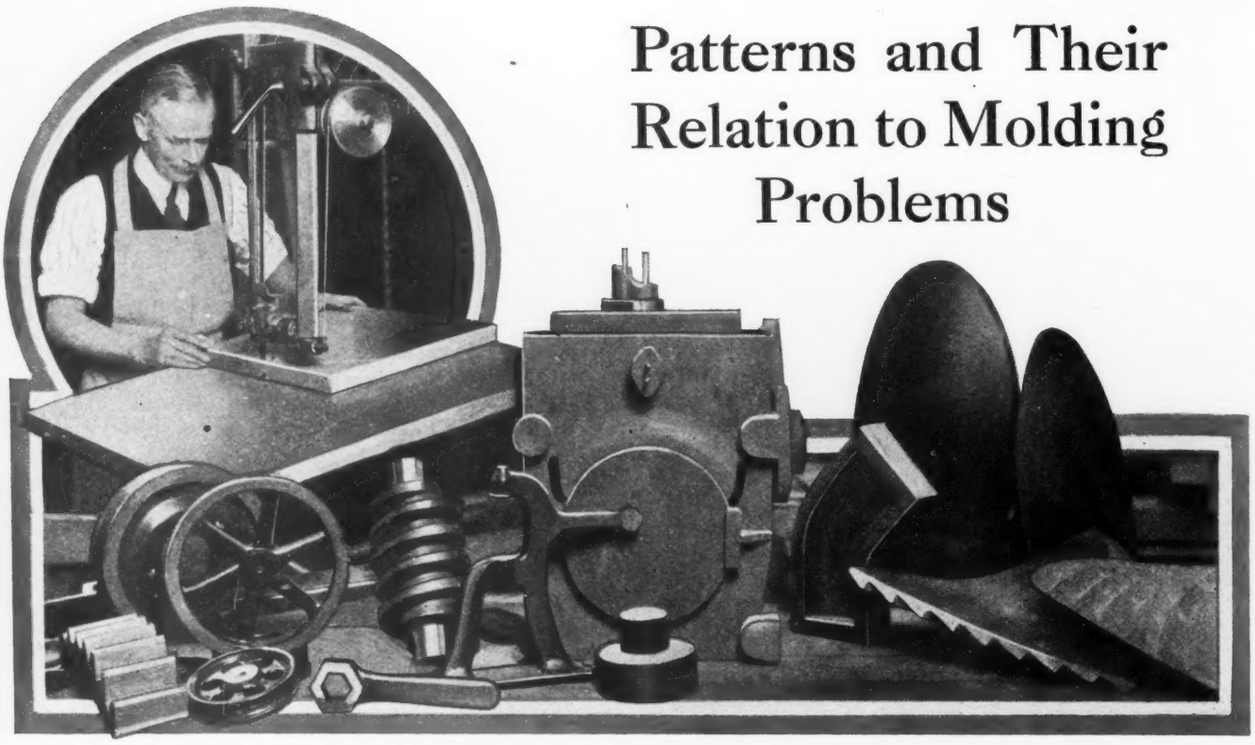
An up-to-date material list will also route the operations to be performed, so that the parts will automatically pass through the factory and finally reach the finished stock-room. When the material list is completed it is sent to the order department, where the material is ordered, and is then filed for reference. Finally, the foremen on getting their orders to do the work, will find the raw material in stock, the castings in the stock-room, the screw machine parts in their bins, and everything running smoothly to the assembling floor or benches. If it is expected that more orders will be received, and it is considered advisable to have a stock of raw material on hand, it is only necessary to consult the material lists and duplicate orders therefrom, and the work proceeds as before.

The material list is used by most large manufacturers for quantity production, and, since its adoption, has proved itself a saver of both time and money. Through its use, the cost department can keep accurate and up-to-date cost accounts, for the list contains an exact and complete record of all materials used.

* * *

ENGINEERING FOUNDATION RECEIVES NEW ENDOWMENT

At a joint meeting of the trustees of the United Engineering Society with the Engineering Foundation Board held in New York on October 7, it was announced that Ambrose Swasey of the Warner & Swasey Co., Cleveland, Ohio, had recently given the Engineering Foundation an additional sum of $100,000 as an endowment for engineering research work. This sum in addition to $200,000 given for the same purpose by Mr. Swasey in 1915 makes his total gifts equal to $300,000. Mr. Swasey's original gift made possible the establishment of the Engineering Foundation by the United Engineering Society, which represents the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. Mr. Swasey who is a past president of the American Society of Mechanical Engineers realizes the necessity for research in engineering sciences in keeping the United States in the forefront of the nations in industrial development in the new peace era, and it is certain that his work and generous donations for this purpose will inspire the cooperation of all those interested in this important work for which more funds are needed in order that the work may be put forward without delay.



Patterns and Their Relation to Molding Problems

First of a Series of Articles Dealing with the Construction and Application of Patterns, Including the Use of Wood-working Tools, the Art of Joinery, and Various Methods of Building Patterns and Core-boxes

BY JOSEPH A. SHELLY

PATTERNS for use in the foundry may be divided into different general types. The term "type," however, as here applied refers to patterns designed to solve certain molding problems resulting from the external or internal form of the casting and is not related to the number of pieces or form of joinery that enters into the construction of the pattern. Types of patterns will be used to illustrate the more common molding problems and their conventional pattern shop solution. It must not be inferred that the problem presented in each case is confined exclusively to a particular type of pattern, as all of the problems referred to could be embodied in a single pattern; they are presented one at a time to avoid confusion. The patterns selected as types are simple ones and the descriptions are purposely made brief, as the same types will be shown a number of times in the more complicated forms to be referred to later, but a careful study of the simpler types is essential if the principles they represent are to be understood and recognized when they occur in other forms. The ability to do this is necessary in determining the type or combination of types to use for a given job.

A Solid or One-piece Pattern

A pattern that is made to be molded without joints, partings, or any loose pieces in its construction is called a "solid" or "one-piece" pattern. It may be a complete model of the required casting or may be partly cored. A simple one-piece pattern that is a complete model even to the central hole is shown in the mold in Fig. 1. The draft or taper to facilitate its removal from the sand is shown some-

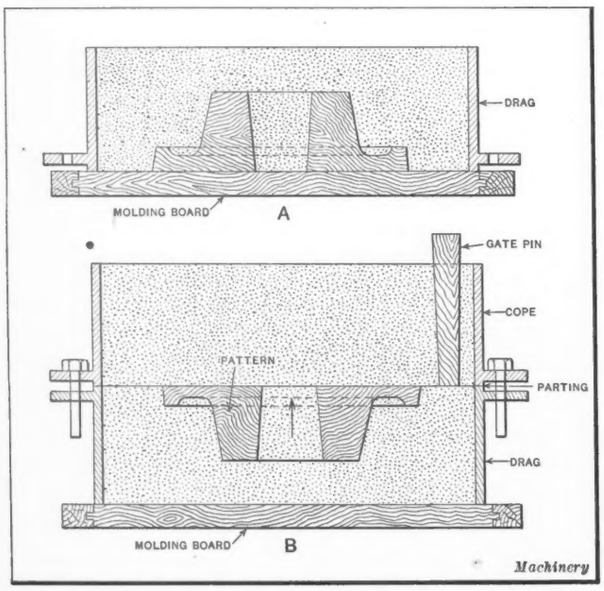


Fig. 1. One-piece Pattern and Method of molding

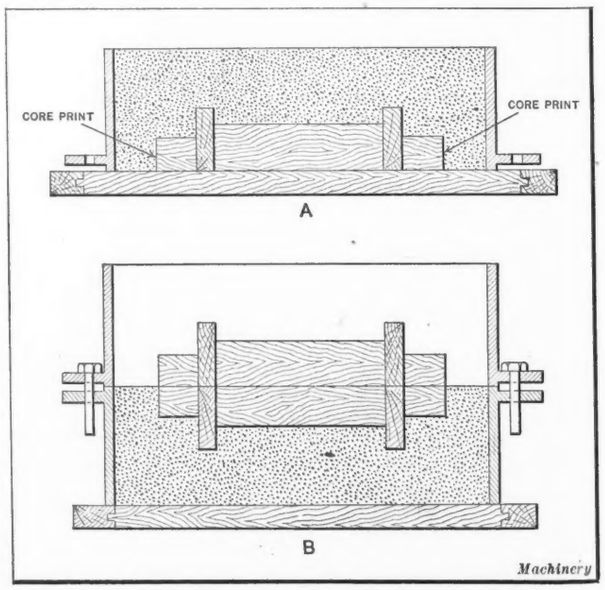


Fig. 2. Method of molding a Parted or Two-piece Pattern

what exaggerated, and the direction in which it is to be drawn from the mold is indicated by the arrow; this taper or draft on any pattern or loose part of a pattern should be made with the larger part on the drawing side.

In molding this pattern, it is placed on a molding board as at *A* with the larger side down, and the bottom or "drag" part of the flask is placed centrally over it; molding sand is then riddled over the surface of the pattern and rammed tightly around it and the remainder of the drag is filled with coarser sand which is rammed flush with the top of the drag. A second molding board is next placed on top of the drag which is then turned over and the first board removed, exposing the cope or larger side of the pattern. The exposed side of the drag is now dusted with parting sand and the "cope" side of the flask is put in place and rammed with the gate pin in position. Before the cope is lifted, it is vented by making a number of perforations through the cope with a vent wire; these vents should run almost, but not quite, to the pattern.

When the cope has been removed, the molder moistens the sand around the edges of the pattern with water applied with a swab. This is done to strengthen these edges so that they will resist the rapping and drawing strains. The mold is finished by "sleeking" and a sprue or runner is cut to connect the mold with the opening made by the gate pin. This gate is enlarged to a funnel shape on the top to permit free entry of the molten metal. The gate, runner, and mold are coated with facing before the mold is finally closed for pouring.

The cope side of the pattern that is illustrated in Fig. 1, is a straight line and the flask and mold partings are straight lines, but this is not always the case; if the outer corners on the cope side were rounded the pattern would be rammed in the drag in the same manner as before, but the parting would have to be cut down all around the edge of the pattern to the place where the round part

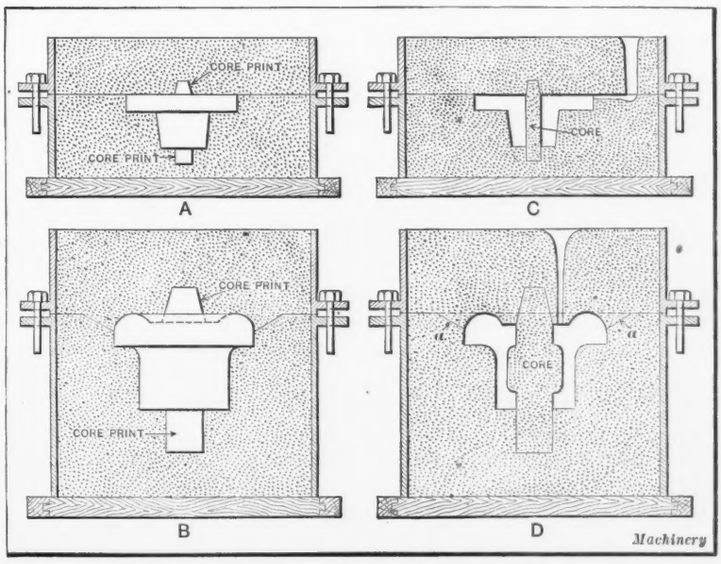


Fig. 3. (A and B) Molds containing Patterns arranged for coring Holes. (C and D) Molds with Patterns withdrawn and Cores inserted

begins, as indicated at *D* in Fig. 3, the lines *a* indicating where the parting has been made. This is called "coping down" and means that the mold parting is carried below the flask parting to include some of the pattern in the cope. It is constantly resorted to in molding patterns that have rounded corners or cope sides of irregular form. If a recess comes within a pattern with a flat cope, it can be included in the cope without digging the joint away.

Solid Patterns Arranged for Coring Holes

Examples of solid patterns arranged for coring central holes are shown in the molds at *A* and *B*, Fig. 3. These patterns instead of being complete models, have in place of the central holes a core-print on the drag and cope sides to support the dry-sand core that is made in a separate core-box. The core-prints for the cope side have a large amount of taper, and the end of the core is tapered to suit, so that, when the cope is put in place, it will center the core without crushing the mold. These core-prints prevent placing the pattern in an upright position on a solid molding board, but this is overcome by boring a hole in the board for the print or by making the prints with pins fitted to central holes, which permits removing and replacing the print. Sectional views of the molds after the patterns have been withdrawn are illustrated at *C* and *D*, Fig. 3. These views show the dry-sand cores in place. A core is used at *C* because the hole is too small and long to leave its own core, and at *D* the hole is chambered or larger at the center than at the ends, and a core is necessary, as a pattern having a hole of this shape through the center could not be withdrawn from the mold.

The Parted or Two-piece Pattern

The simplest form of parted pattern is the one made in two sections that are held in their proper relative positions by means of dowel-pins fastened in one piece and fitting

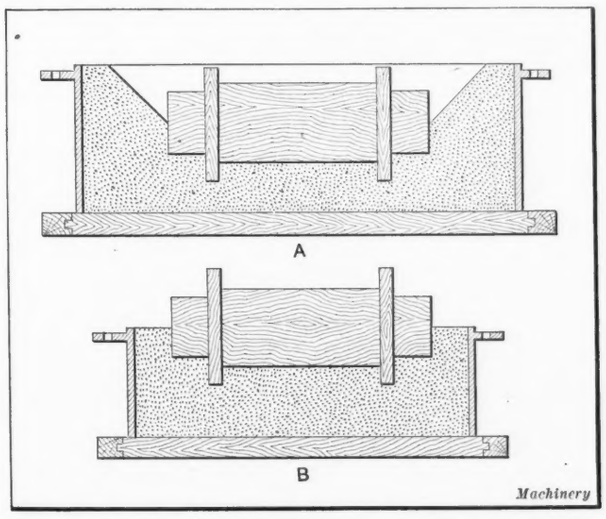


Fig. 4. Illustration showing Disadvantages of molding a Solid Pattern which is not parted through the Center

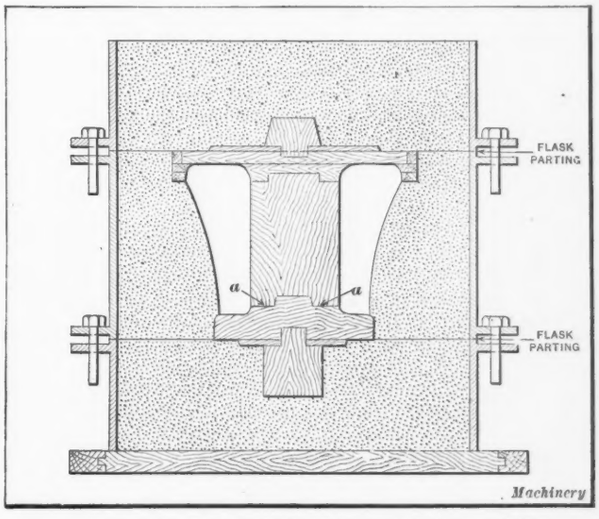


Fig. 5. Illustration showing Typical Three-part Pattern molded in a Three-part Flask

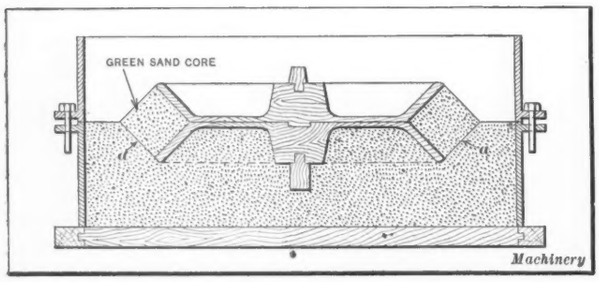


Fig. 6. Three-part Pattern molded in a Two-part Flask

holes bored in the other. A cylinder with end flanges that prevent its being molded on end is a good illustration of a parted pattern. Such a pattern is molded by placing one half on a board with the drag side of the flask over it, as shown at *A*, Fig 2. After ramming, the drag is turned over and the cope side of the flask and pattern is placed in position for ramming, as shown at *B*.

The advantage of this two-piece pattern construction is that a straight joint is secured and it is not necessary to dig away the parting and cope down to the center, as would be the case were the pattern made solid as shown at *A*, Fig. 4. There is, however, another way of molding a pattern of this type known as "bedding in." To do this, the flask is placed on the board with the joint side up and is rammed full of sand; a cavity is then roughly dug in it large enough to receive the pattern up to the center or parting line, as shown at *B*, when it is ready for the cope. Aside from the extra labor of making the joint, the cope side of the flask must be lifted away from the pattern while

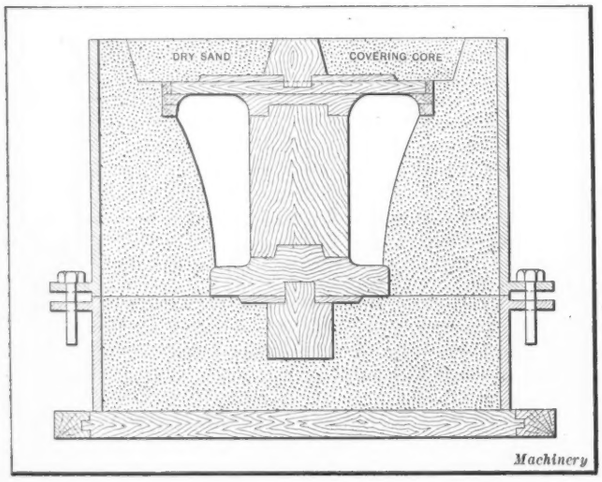


Fig. 7. Another Three-part Pattern molded in a Two-part Flask, a Covering Core being used

with the parted pattern one half lifts out with the cope and there is less danger of damaging the mold.

Patterns too large to be molded in a flask or too heavy to be turned over are always molded by bedding in, and they may be parted even if the molding is done in this way. For example, in column foundries, parted column patterns are molded in flasks by "bedding in" to avoid turning them over. These patterns are sometimes made so that the end prints that carry the core project through openings in the end of the flask that keep the pattern joint flush with the flask joint; with this arrangement, the pattern is not really "bedded in," because there is no digging away, the pattern being rammed up with the joint of the pattern and flask facing upward. When molding a piece in the foundry floor by "bedding in," a level bed is prepared and this is dug away to accommodate the pattern. Another adaptation of the two-part idea in pattern work occurs when there are projections on the cope that will be difficult to lift away or "cope off." To avoid damaging the mold, these projections are doweled to lift away with the cope, and the pattern is said to have a loose cope side. If the cope side is straight, it is a good plan to make all the projections to lift away.

The Three-part Pattern

A three-part pattern usually consists of two pieces, but its form is such that it must be molded in a flask having three sections. The pattern shown in Fig. 5, rammed up in a three-part flask, is a typical example; the pattern is parted on the lines marked *a*. This parting does not coincide with the flask parting and necessitates digging away some of the sand in the "cheek," or central section of the mold, which is rammed up first in order to bed the smaller flange in it. The flask is disjointed to release the pattern by lifting the cope away from the tapered core-print and facing piece and drawing the pattern through the top of the cheek and then lifting the cheek away to release the small flange which is partly in the cheek and partly in the drag.

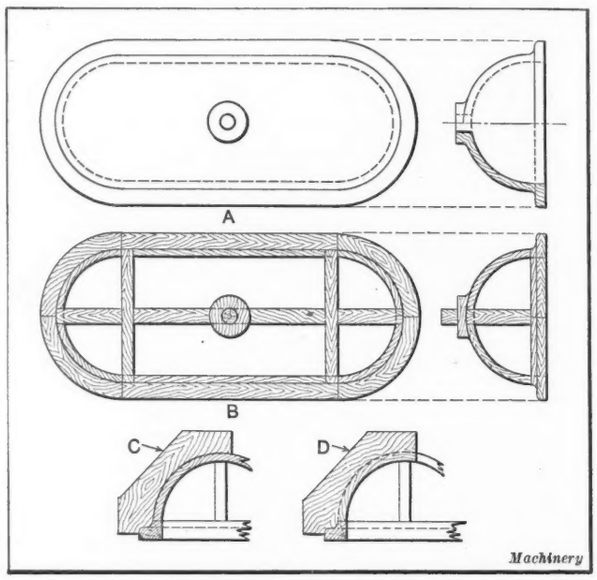


Fig. 8. (A) Casting. (B) Skeleton Pattern. (C and D) Strickles used with Skeleton Pattern

It is quite possible to mold some three-part patterns in a two-part flask by ramming up the drag, turning it over, and digging the joint away on the line marked *a*, Fig. 6, all around the pattern. Parting sand is then dusted over the joint, the cope side of the pattern is put in place, and the V-shaped green-sand core is formed as shown; this core, in turn, is treated with parting sand and the cope rammed up. By lifting the cope, one half of the pattern may be removed; the cope is then replaced, the mold turned over, and the drag lifted to release the other half of the pattern.

Another method of handling a job of this kind in a two-part flask is by the use of a covering core. This is a core (see Fig. 7) made to fit the cope side of the pattern which at first stands in the core while the latter is placed on a

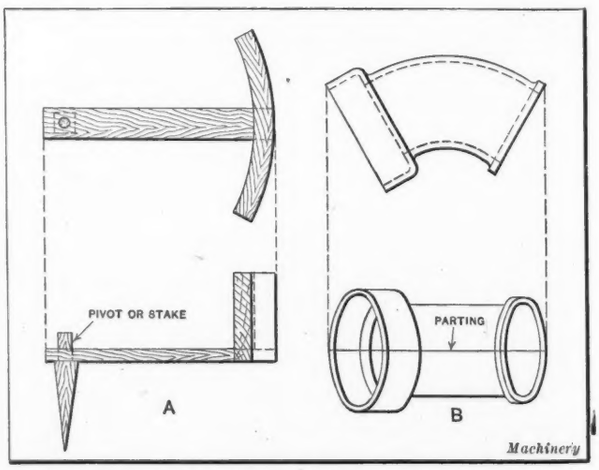


Fig. 9. (A) Segment Pattern used for forming Wheel Rim Mold. (B) Shell Pattern

board. Both are rammed up to the flask parting line; the drag is then rammed, the mold turned over, and the covering core lifted out to release the larger part of the pattern which is drawn through the top of the mold. The cope part of the flask is lifted to release the rest of the pattern. This is a conventional method for removing parts of patterns that must draw through the top or the sides of a mold. The covering core may be round, square, or rectangular, which ever is most convenient, but in any case it must leave an opening large enough to draw the pattern through. A print is sometimes provided for the core instead of ramming it up with the pattern. There is practically no limit to the number of flask sections that might be used to mold a job, but the essential principles of molding are covered by the examples already given.

Skeleton Patterns

Skeleton patterns are wooden frames designed to aid the molder in forming a portion of the pattern in sand or clay. The sand or clay is rammed inside the frame and worked to form by pieces of wood with suitably shaped edges called "strickles"; the act of working a surface to form with a strickle is called "strickling." A casting is shown at *A*, Fig. 8, and the skeleton pattern used to produce it, at *B*. The pattern ribs are fastened to the bottom flange and to the rail at the top which also holds the boss with its core-print. The ribs conform to the outline of the casting and represent a section of it. The strickles *C* and *D* are used to form the outside and inside of the frame when it is filled with sand. In molding, the frame is set on a level sand bed with the flange down and is filled with sand. The sand pattern is formed by strickling off the outside with strickle *C*. A half flask is placed over it and the surface of the sand pattern is dusted with parting sand. The flask is then rammed up and lifted away, after which the surface of the sand pattern is scraped away and strickle *D* is used to form the inside or core before the frame is removed. This is a typical job and should suggest other applications. One of the main requisites of any strickled job is that there be good means for keeping the strickle in the path in which it should travel.

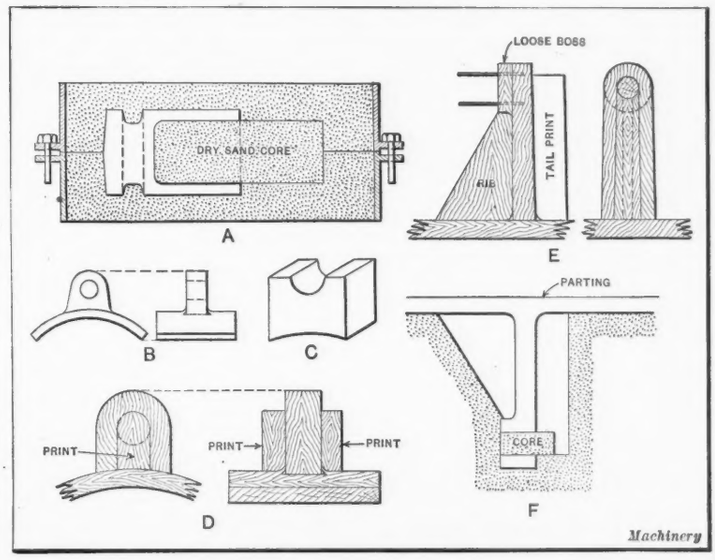


Fig. 12. (A) Core which balances Unsupported End. (B, C, D, and E) Examples illustrating Use of Tail Prints. (F) Section of Mold formed by Pattern E, with Core in Place

Part Patterns

Part patterns are sections of a pattern so arranged as to form a complete mold by being moved to form each section of the mold. The movements of a part pattern are either guided by following a line or by the use of a central pin or pivot. These patterns are generally applied to circular work such as rings, wheel rims, gears, etc. A part pattern in the form of a segment guided from a center and used for forming the outside of a wheel rim is shown at *A*, Fig. 9. Another type of part pattern is the frames used for making plate castings. Instead of a full pattern a frame two or three inches wide is made conforming in thickness and outside dimensions to the required casting. This is molded by "bedding in" and the sand in the open part of the frame is swept away with a strickle.

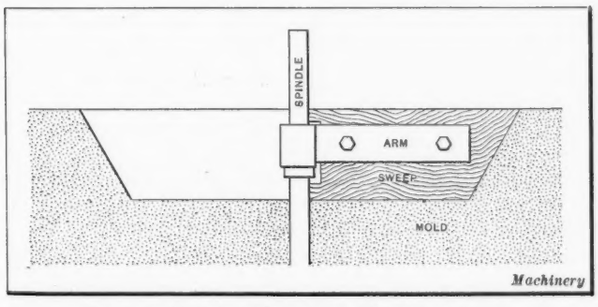


Fig. 10. Forming Mold with a Spindle and Sweep

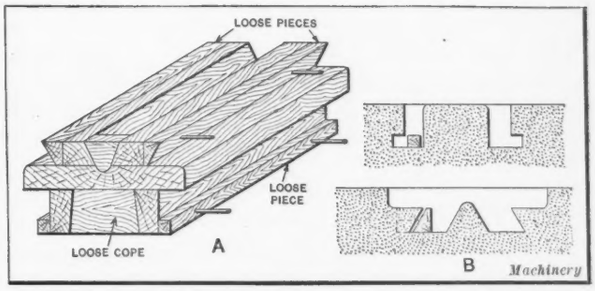


Fig. 11. Pattern having Loose Pieces which are removed from Mold separately

Shell Patterns

The shell pattern is used largely for drainage fittings and pipe work. A typical example is shown at *B*, Fig. 9. The pattern is usually made of metal and parted along the center line, the two sections being accurately doweled together. In molding, these two halves are clamped together and the core of green sand is rammed up inside them. The ends of the core are built out beyond the ends of the pattern, being roughly formed to ball shape. The pattern and core are then imbedded in the drag part of a flask to the parting line and the cope rammed up. To draw the pattern, the cope is lifted away and one half of the pattern removed; the cope is then replaced, the entire box turned over, and the drag removed to draw the other half of the pattern.

Spindle and Sweep Work

This is a method of forming circular molds by revolving a sweep attached to a spindle, the edges of the sweep forming the mold. Molds may be formed in part or completely by this method and, when so formed, are said to be "swept up." This method may be applied to green, dry sand or loam work, and is illustrated in Fig. 10.

Patterns Molded with Drawbacks

"Drawbacks" are iron plates inserted in a mold to carry under-cutting projections that cannot be drawn into the mold, or they may be integral parts of the pattern itself. They are called drawbacks because an open space is left back of them into which they are drawn with the portion of the mold they carry. They are used frequently on jobs molded in the foundry floor or in dry sand work in flasks.

Patterns with Loose Pieces

Many patterns are of such shape that the projecting parts form under-cuts that prevent their being drawn with the

main body of the pattern. These under-cuts may come in the cope, drag, or cheek of a mold, or they may be undercutting projections on loose pieces, and the pieces forming them should be fastened in place with loose dowels or "skewers," as they are called. This permits the freeing of the pattern by the removal of the skewers, the loose pieces remaining in the mold when the pattern is drawn and, in turn, being drawn into the cavity left by the pattern. The pattern *A*, Fig. 11, has loose pieces in both cope and drag, and the mold sections at *B* show how they are drawn; this is called "picking in." When the cavity is smaller than the piece to be "picked in," it is made in two or more pieces, each being picked in separately. In order to pick in projections on the sides of large boxes or beds that leave their own cores, it is customary to ram the inside up on an iron plate provided with eyebolts for the purpose of lifting the core away to release the projecting parts. To avoid picking in or the use of drawbacks, projections on castings are often formed by making the projecting part in a core-box, placing the core against the pattern in its proper place, and ramming them up together; or a core-print may be provided to set the core after the pattern is molded. Trunnions and hinge lugs on boxes are often formed in this way.

Core-prints

The projections placed on patterns to locate or support cores are of four general types known as "cope and drag prints," "joint or parting prints," "balancing prints," and "tail, heel, or drop prints." Cope and drag prints are so called because they are placed on the cope and drag side of a pattern. The cope-print should be made with considerable draft, as the cope must be lowered over the end. There is no rule fixing the length of core-prints. Up to three inches in diameter, the length of a drag print might be made equal to its diameter and the corresponding cope-print, one half the diameter. The larger the core and the greater the bearing surface, the shorter the print. The small core requires a long print for supporting it while a print is used only as a means to locate a large core, and, in such a case, a cope-print would be superfluous. Many large flat cores are located in the mold entirely by measurement. Joint or parting prints may be solid or parted in the same way as the pattern, depending entirely upon whether the cored opening is above, below, or central with the parting. They are used to support the ends of cores that cut through the sides of the mold.

Balancing Core-prints

When a core is supported at one end only and extends a considerable distance into the body of the casting, it should be made long enough to balance the weight of the unsupported end as shown at *A*, Fig. 12. This method can be applied only within reasonable limits. It would be of no use to attempt to balance a core with a print five or six feet long. In such a case, the unsupported end must be held up by chaplets. When an opening cuts through one side wall above or below the parting, the print may be made loose and be picked in. The core-print in this case should be long enough to balance.

Tail, Heel, or Drop Prints

Tail prints are used when an opening is to be cored above or below a parting. They may be of any size or shape and should be made with plenty of side taper or draft. The casting *B*, Fig. 12, has a projecting piece or lug on one side through which an opening is cored. A portion of the pattern for this casting with the tail prints in place is shown on an enlarged scale at *D*. The stopping-off piece *C* is a duplicate of the projection or lug up to the center line of the hole and is cut out to fit over the core. After the pattern has been drawn and the core set or put in position, the stopping-off piece is dropped into place and the void left by the tail print is filled in over the core. Another condition requiring somewhat different treatment is shown at *E*. The lug has a projection or boss on one side that must be made loose and picked in. It would be inconvenient to put a tail print on the boss side; therefore, a particularly long one is placed on the plain side. This print must be a trifle longer than the length of the hole to be cored plus a fair amount of bearing or supporting surface. The view at *F* shows a section of the mold with the core in place. Tail prints can be made in a core-box, but this usually makes an unsightly mark on the casting.

When some doubt exists as to the best method of molding a pattern, the molder or foundryman should be consulted, particularly if the job is a large one, as the rigging and appliances he has on hand will be a factor in determining how the pattern should be molded.

* * *

DRAWING OF METAL SHELLS

BY JOHN NELSON

The writer is engaged in introducing a device which, when attached to a press used for drawing thin metal shells, can be made to exert an even pressure on the top of the blank during the entire stroke of the press. This device holds the blank down tightly on the top of the forming die and prevents the blanks from wrinkling. In connection with this work the writer has had an opportunity to observe many problems in metal drawing. The object of this article is to give some information gained through experience and to encourage others to tell their practical experiences in overcoming problems encountered in this class of work.

One of the most important things to be accomplished in conjunction with the drawing of metal shells is to provide means of exerting the proper amount of pressure on the draw ring during the entire stroke. This is especially important when a light gage of metal is drawn, as this has more tendency to wrinkle. The most critical part of the draw is in the beginning of the stroke, as there is then a larger surface to be reduced. Therefore the greatest pressure should be applied on the draw ring at the beginning of the stroke. Appearances are deceptive in this connection, as the wrinkles always appear at the top of the shells and therefore it would seem as if the wrinkles were formed at the end of the draw, but anyone can prove for himself that the wrinkles are formed in the beginning, by making about one-third of the draw and then observing the appearance of the blank. It will be found that the blank is now smooth near the center and wrinkled at its outer edge. These wrinkles sometimes jam in between the male and female parts of the die and cause the metal to stick and the punch to break through.

The chief function of the draw ring is to prevent wrinkling, but this fact is not always understood. If a cup that has straight sides is to be made, all that is required of the draw ring is that it keep the metal smooth until it passes over the edge of the cavity. If the metal is of a heavy gage, however, about 0.050 inch or more, only enough pressure will be required to keep the metal from lifting the draw ring, as there is no tendency to wrinkle in the heavy metal, but if a light gage of metal is drawn, heavy pressure must be used on the draw ring, as it has a greater tendency to wrinkle.

The best results along this line can generally be obtained by using a good lubricant on the blank and applying all the pressure on the draw ring that the metal will stand without breaking. When shallow, concave shells are drawn, the conditions are entirely different. The problem then, in addition to keeping the blank from wrinkling as it is reduced, is to hold the metal back so that it will stretch and be formed without wrinkling the portion inside the draw ring. Under these conditions it is not advisable to use a lubricant, but on the other hand it is advisable to apply gasoline to the thin sheets in order that their surfaces will not slip so easily. In some cases a bead is formed on the draw ring which fits into a corresponding groove on the die. With this method the metal can be held back to a greater extent. Occasionally in making shell draws, the metal should be held firmly around the edges and simply stretched enough to give it the desired shape.

TAPPING AND ASSEMBLING OPERATIONS IN A DRILLING MACHINE

BY DONALD A. HAMPSON

TWO million steel pieces, 15/32 inch long, were to be tapped with a 7/64-inch tap having 48 threads per inch. The hole to be tapped was 5/16 inch deep and was not a through hole, and the working margin for the tap at the bottom of the hole was therefore limited. This fact and the delicate nature of taps of the size indicated made it imperative to study the conditions carefully so that methods of tapping might be devised whereby losses through tap breakage could be kept down and a profitable rate of production maintained. A great deal, of course, depended on the skill of the operator, as was indicated by the production of different operators, which varied from 1500 to 1700 pieces a day. In studying the conditions, it was found that tap breakage resulted from the taps being too hard, the spindle and tap not being correctly lined up with the work, the chuck having too positive a drive, the tap striking the bottom of the hole, and through the shock of reversal or of striking the top of the work too suddenly. These difficulties were successfully overcome as follows:

As a precaution against using taps that were too hard, all were drawn in oil to a temperature of 540 degrees F. Inspection showed that none of the broken taps were worn

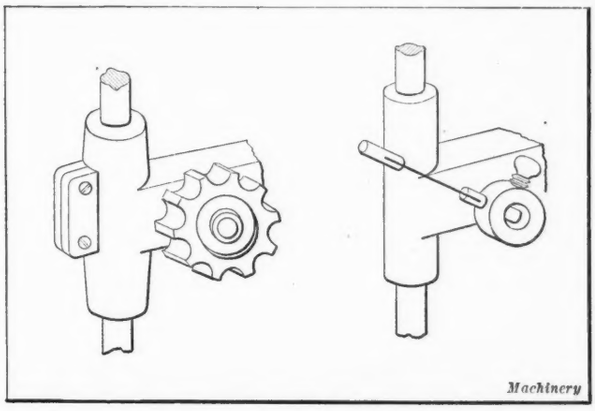


Fig. 1. Shock-eliminating Feeding Devices for Tapping Machines

out or dull. Therefore there was a liberal margin in the life of commercial taps before the wearing point equalled the breaking point. The lining up of the spindle and the work was a matter of set-up, and was so accomplished that changes would not occur under normal working conditions. Friction tapping devices were used which could be set to slip before the taps would break. This part of the work was done by skilled men who kept the only tools for making adjustments so that no tampering could be done after a setting was made. To prevent striking the bottom of a hole the regular stop of the tapper was replaced with a shoulder stop and the taps were carefully set in the chuck. The set-up man then carefully adjusted the stop so that the tap could not strike the bottom of the hole. Greater chip clearance was provided by grinding off the ends of the taps. Lubrication and clearing of the chip space in the flutes was taken care of by arranging a brush to bear against the tap just above the work. This cleaned the tap and an oil-can, set to drip on the same brush, furnished a sufficient quantity of lubricant.

Friction Drive and Shock-absorbing Feeding Devices for Tapping Machines

Those who have operated reversing tappers know that it is often necessary to reverse the tap to free it of chips. A properly set friction will slip when the chips become tightly packed and the remedy, then, is to turn the tap backward a couple of times so that the chips will work out of the flutes. In his haste to reverse the tap, the operator often lifts up too suddenly on the feed-lever, thus breaking the tap even though its temper has been carefully drawn. In the following cases the work was done by the simplest of bench drilling machines, the spindle and feed of these being so arranged as to avoid the shocks mentioned. The addition of a tapping device overbalanced the counterweight,

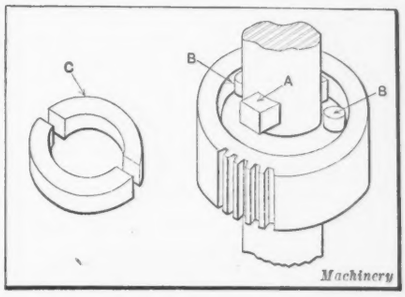


Fig. 2. Method of using Split Ring to cut out Reversing Mechanism of Tapping Machine

but by weighing the assembled spindle, the exact amount to be added to the counterweight to restore its balance was found, and to this was added two or three ounces so that the vibration of the machine when running would cause the spindle to remain up, if it was affected at all. The touch of a finger would then raise or lower the spindle.

In Fig. 1 are shown two forms of shock-eliminating hand-feed devices which were used to replace the conventional ⅜-inch rod. The one at the right consists of a piece of spring steel set in place of the rod, having a round piece of wood attached to the free end in order to provide a better grip. This cushioned the reversing motion in both directions and made it impossible for the workman to bring the tap into contact with the work too suddenly. The only fault of this device was that it was "too much like a feather," as one man expressed it. The other illustration shows a 3-inch handwheel attached to the pinion shaft in place of the lever. This, in connection with the nicely balanced spindle proved to be a successful arrangement, as the operator depending almost entirely on the sense of touch was enabled to maintain the maximum safe rate of feed.

Method of Cutting out Reversing Mechanism of Tapping Machine

The tapping machine with a friction chuck may be used for a variety of non-reversing work by cutting out the reversing mechanism. The method of accomplishing this is shown in Fig. 2, and was applied to an Errington tapper, but this method may be applied to other types of construction. The vertical shaft is driven by the square key *A* that passes through it and carries at its lower end the friction chuck for the tap. This shaft has an up and down movement of about ½ inch. When the shaft is at its highest position the key engages the forward driving pins and when it is at its lowest position the reversing pins *B* are engaged. These pins are driven in the counterbored side of the reverse gear. Contact with the work forces the shaft up when it is driven forward and raises the feed-lever of the drill,

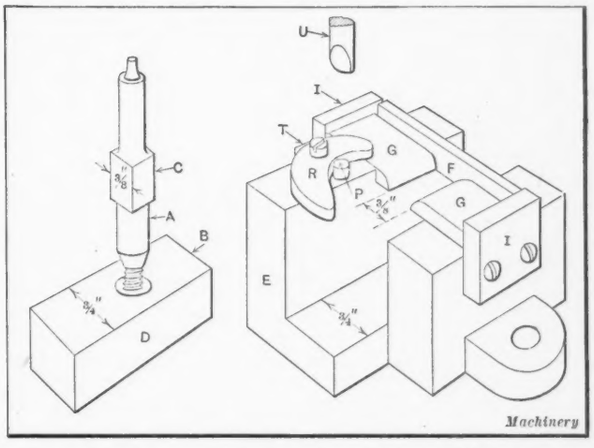


Fig. 3. Work to be assembled and Fixture used in Assembling Operation

bringing the reverse pins into operation, and the tap is thus backed out of the hole. By placing a split ring *C*, as shown to the left, inside the counterbore of the reverse gear, the space is filled up level with the top of the pins *B*, thus allowing the key to ride over the tops of the pins without reversing the chuck.

One class of work required a great many light packing boxes with hinged lids, the hinges being fastened with No. 5 screws. By setting the friction device, these screws were driven in so that they were held with a uniform tension. A manufactured specialty was produced having a ⅜-inch fillister-head screw with a nut run on up to its head. In this case the screws were run into the nut by a screwdriver point held in the chuck, the friction device detecting any that were too tight a fit, as it would slip instead of inserting the screw.

Assembling Brass Parts

Fig. 3 illustrates a job of unusual interest. The stem *A*, shown at the left, has a ¼ inch by 32 thread ¾ inch long by which it is assembled in the block *B*. Both parts are of brass and are leaded to make an air-tight joint. The block is countersunk and the taper on the stem is made to fit the countersunk portion of the block. It is necessary that the side *C* of the stem be parallel with the side *D* of the block when *A* is driven in. If not parallel when the taper parts are seated, the metal will stretch enough to allow them to be brought parallel by exerting a little pressure on the screw, which means at most only the turning in of another 0.01 inch.

The method of assembling was to have a boy lead the stems and start them in by hand, placing them within easy reach of the drilling machine operator who ran them down with the machine by using a cut-out piece to hold the block *B* and by driving the stem *A* by a piece held in the chuck of the tapper which was constructed like a deep-socket wrench. This was brought down over the stem while the machine was running. In this instance it was undesirable to have the tapper reverse. By properly setting the friction, the stems were screwed in to a uniform fit, thus eliminating the danger of twisting them off. However, very few of them came in line and it was necessary to correct them by hand.

After some experimenting the device shown at the right in Fig. 3 was designed to align the stems at the same time that they were screwed down. *E* is the base which is fastened to the table of the drilling machine. It has a channel in which the blocks are placed, their position being determined by the cross-piece *F* which acts as a stop for locating stem *A*, as well as a connecting piece for the jaws *G*. These jaws have square ends fitted with round stems which slide in reamed holes in the sides of block *E*. They are shown down, but compression springs force them up when released by latch *R*. Internal stops prevent them from rising above the top of guides *I* which are for the purpose of preventing the rotation of the jaws *G*, thus relieving the cross-piece *F* from any stress.

A latch *R* holds the jaws down against the force of the springs. This latch is limited in its travel by the pin *P*, and is normally kept in the position shown by the flat spring *T*. The depth stop rod of the tapper *U* is beveled off at the lower end and the tapper is confined to a vertical travel so that the bevel end makes contact with the free end of latch *R*, moving it to the left and suddenly releasing the jaws *G*. The jaws are returned to their normal position by hand pressure and the latch snaps into place, thus holding them in their former position. In operation, the stem is screwed in as described in the first case but with this difference—the stop rod is so set that by the time the stem has reached its minimum seating depth, the latch is released and the jaws fly up against the lower edge of the square portion of stem *A*, rising still further the next instant when the sides of the stem are turned parallel with the jaws. The driving piece continues to revolve but can cause no harm, as the friction device allows it to slip without turning the work. One of the requirements of the job was that the surface of the brass should not be marred and it was possible to meet these requirements with the equipment described.

Another assembling job in which a round nut was screwed tight on a ⅛-inch steel rod was accomplished in the following manner: In this case it was necessary that the nuts be screwed to a uniform tension. A small bench vise was clamped to the table of the drilling machine and the rods held upright by resting against the bar of the vise. The nuts were then started on by hand. A friction device fastened in the spindle and carrying a driving chuck of the ball grip type was used. In this chuck three 5/16-inch steel balls rolled up an incline when they came in contact with the work, thus forcing them toward the center in an ever-tightening grip. The rods required no vertical setting, and it was only necessary for the operator to bring the feed-lever down until the stop inside the chuck came in contact with the nut. This operation could be performed almost instantaneously.

* * *

SOME PROPERTIES OF PLATINUM

A bulletin recently issued by the information bureau of the American Museum of Natural History contains some interesting facts about the discovery, properties, and utilization of platinum. In this bulletin it is stated that the marvelous ductility of platinum may better be conceived when we consider that out of a single troy ounce of the metal it would be possible to make an almost infinitely slender wire that would reach from Santiago, Chili, across the continent to Rio de Janeiro, a distance of about 1800 miles. To draw out platinum into so exceedingly fine a wire it is covered with a thin layer of gold. This new wire is drawn to the thinness of the former one and the gold is dissolved. A small section of this second wire is then given a coating of gold, redrawn, and the gold covering dissolved. After this process has been repeated several times, the wire finally obtained is still intact, but virtually invisible.

Platinum is of great importance to our Ordnance Department at the present time, and efforts have been made to restrict its use in the making of jewelry and non-essential products. Especially is this necessary since the Russian supply, which constituted over 90 per cent of the world's production, has been cut off by the war. The deposits in Colombia rank second to those of Russia, but while they are being developed more rapidly than formerly, they go but a small way toward making good the loss of the Russian supply.

Platinum is a comparatively recently discovered metal. The earliest knowledge of its existence dates back only to 1735. In 1741 Charles Wood, an English metallurgist, brought specimens of the new ore from South America to England. In 1901 the value of one troy ounce was $14.12; in 1905 it was $17.03; in 1914 it was quoted at $35.05; while at present pure platinum is worth over $100 an ounce.

* * *

According to statistics compiled by the United States Geological Survey of the Department of the Interior, the iron ore mined in the United States in 1917 reached a total of 75,288,851 gross tons, exceeding the output of 1916 by 121,179 tons. The shipments from the mines in 1917 were 75,573,181 gross tons valued at $238,260,333, a decrease in quantity of 2,297,372 tons or 2.95 per cent, and an increase in value of $56,358,056, or 30.98 per cent as compared with shipments in 1916. The quantity of pig iron, exclusive of ferro-alloys, used in 1917, amounted to 38,612,546 gross tons valued at $1,053,785,975 as compared with 39,126,324 gross tons valued at $663,478,118 in 1916, a decrease of 1.32 per cent in quantity and an increase of 59 per cent in value.

* * *

An employe who was seriously burned while lighting a cigarette by the ignition of a turpentine-saturated bandage that covered an injury received during his employment was said, by the California Industrial Accident Commission, to have been injured in the performance of his employment.

ACCIDENTS IN METAL-WORKING INDUSTRIES

A chart 14 feet long and 20 inches wide was an interesting feature of the accident prevention exhibit at the Seventh Safety Congress held at St. Louis, Mo., in September. The chart was prepared by the Industrial Commission of Wisconsin and is a comprehensive analysis of 41,000 industrial accidents, resulting in a theoretical loss of 6,000,000 working days. Five hundred and nineteen deaths are scheduled as having taken place during the three-year period covered by the chart, together with 2400 permanent disabilities and about 38,000 temporary disabilities, each causing more than seven days lost time. Of these 41,000 accidents, only 7800 were caused by power-driven devices, of which 2660 were on metal-working machinery. Of the latter, nine resulted in death, nearly 500 in permanent injury, 1100 in temporary disability of two weeks or longer for each workman, and more than 800 caused one week or more of lost time. The classification, in part, is shown in Table 1.

TABLE 1. ACCIDENTS OCCURRING THROUGH USE OF METAL-WORKING TOOLS

Type of Tool	Total Number of Accidents	Number of Deaths	Number of Permanent Injuries	Number of Days Lost
Borers	24	..	5	2,174
Buffers and polishers	51	..	1	1,353
Bulldozers	6	..	1	1,311
Drills, vertical	256	2	27	34,051
Sanders	3	..	..	35
Emery wheels	422	..	28	36,787
Hammers, drop	53	..	10	6,733
Hammers, steam	43	..	5	4,641
Lathes	289	..	37	25,367
Milling machines	98	..	13	11,735
Planers	43	1	7	12,855
Pneumatic chisels	8	..	..	101
Pneumatic drills	10	..	1	554
Pneumatic hammers	19	..	..	449
Pneumatic riveters	18	..	3	1,186
Presses	810	1	257	176,273
Reamers	38	..	2	6,746
Riveters	38	..	9	7,988
Rolls, steel mills	33	1	5	15,058
Saws	40	..	9	5,629
Shears	124	..	31	2,065
Spinning machines	8	..	2	2,185
Tumbling barrels	6	1	1	6,403
Wire drawers	5	1	..	6,095
Automatic metal-working machines	10	..	2	761
Other metal-working machines	205	2	34	36,357

Machinery

Under the heading of General Machinery, it is found that engines and motors caused 387 injuries, including 5 deaths—some of these occurred in metal-working establishments, although specific classification is omitted. Transmission apparatus, such as belts, gears, pulleys, etc., added 201 injuries, with 13 deaths, to the total; while boilers, fans, and other general types of machinery were responsible for 226 accidents, all grouped by causes rather than by injuries. Elevators caused 257 accidents of which 17 were fatal.

It will be seen by referring to the list presented in Table 2 that the majority of the accidents were caused through the handling of objects, which includes dropping, being caught between objects, handling rough or sharp objects, etc. Nearly all these accidents are the result of thoughtlessness and can only be prevented by persistently teaching the workmen to "think safety." The handling of sheet metal caused 255 accidental injuries, including one death, and more than 12,000 days lost time; while slivers caused 674 accidents and resulted in over 30,000 days lost time.

DAMASCENE STEEL

Damascene or Damascus steel is the same material which was imported in the Middle Ages to Western Europe through Syria and Palestine, and is known also as Indian steel and bulat. A characteristic of this steel is its surface patterns which vary with the carbon content, causing wavy parallel stripes and mottled patterns to appear on the surface, the latter pattern being considered to indicate the most perfect grade of steel. It is stated in a paper by Colonel N. Belaiew, read before the Iron and Steel Institute, that certain damascene blades upon analysis show high carbon content, being in some cases as high as 1.50 per cent, and in all cases from 0.70 to 0.80 per cent.

There are, it appears, three principal methods of producing real damascene steel: the old Indian custom of producing crucible steel from pure ore and the best grade of charcoal; the Persian practice, when the charge consists of soft iron bars and charcoal and plumbago; and a third method consisting of a certain heat-treatment of steel, resembling a prolonged tempering. One scientist has concluded that the carbon irregularly dispersed in the metal and forming two distinct combinations, is what occasions the damask and that the slower the cooling the larger the veins will be. The general but erroneous opinion is that the variegated surface of Oriental swords resulted from their being composed of a compound of bars and wires of iron and steel, welded and wrought together and then twisted by forging in different directions. This belief confounds the real damascene steel, which has its microstructure appearing on the polished surface, with that of its imitation, the wrought damascene.

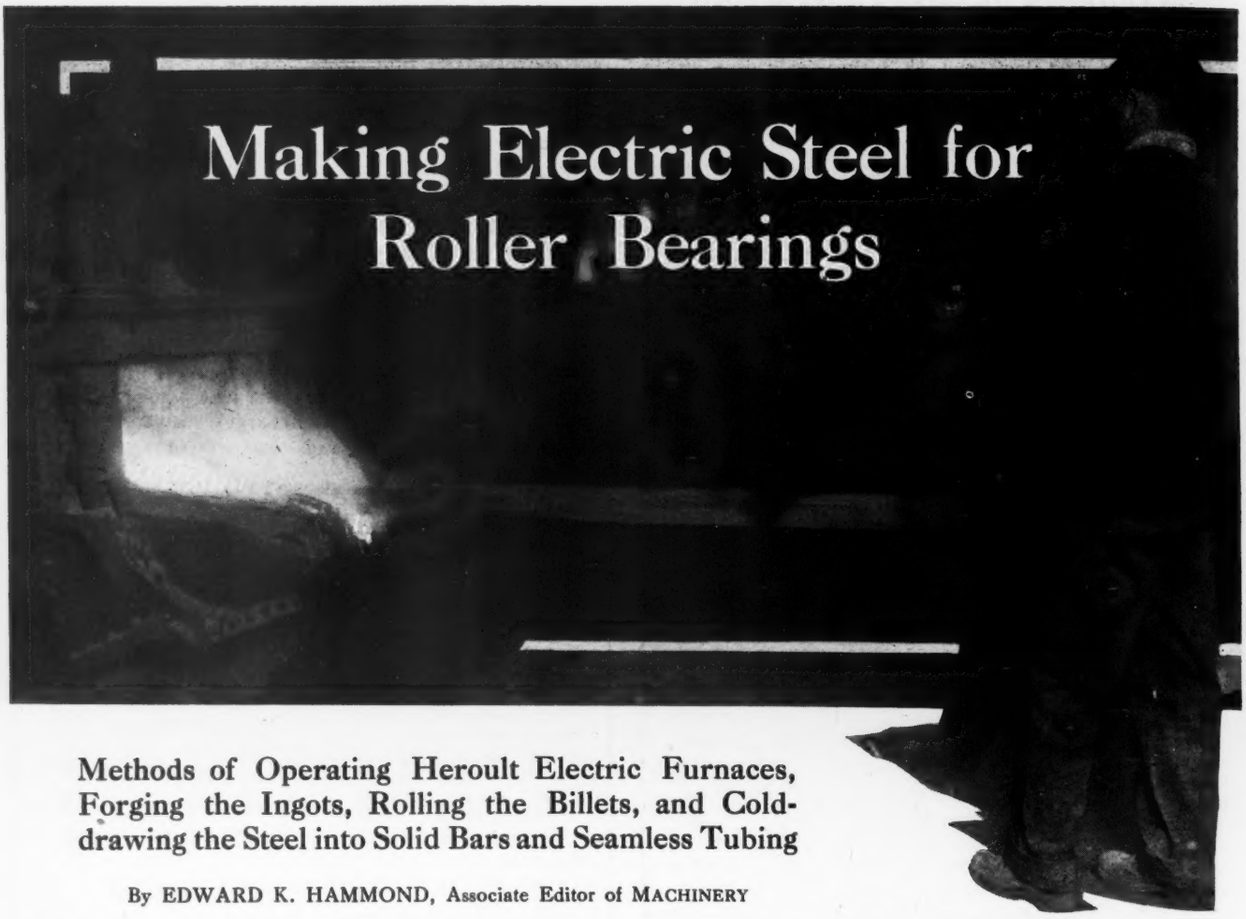
TABLE 2. CAUSES OF ACCIDENTS IN METAL-WORKING INDUSTRIES

Cause of Accident	Number of Accidents	Number of Days Lost
Falling objects, total	2478	149,785
From chutes and slides	158	5,471
From conveyors	58	1,295
From machines	270	7,401
From racks and shelves	495	25,464
From work-benches	147	3,571
From objects tipping over	944	60,366
From piles falling	108	8,589
Flying particles, total	751	173,016
From metal in chipping	271	66,481
Falls of persons, total	4160	397,632
From loading platforms	82	14,634
From runways and balconies	66	12,397
From stairs	321	28,806
From benches, boxes, chairs, and tables	134	6,993
From machines and boilers	116	25,504
From piles	85	11,821
Into bins and pits	65	14,784
Into excavations	25	9,063
From jumping voluntarily	26	16,120
From jumping involuntarily	100	5,770
From stepping on rolling objects	152	4,569
From stumbling	572	34,495
From slipping	1933	84,963
From stepping on nails or other sharp objects	481	14,092
From striking against nails or other objects	1461	126,306
From injuries resulting from hard tools	3093	142,505
From handling of objects	9221	545,760

Machinery

The clearer the glitter and the nearer to a golden tint, the more perfect it is. A dagger blade of good damascene steel, properly polished and correspondingly hardened, cannot be broken by bending, but can be bent to such an extent that it loses its elasticity. When bent in the usual fashion, the blade flys back and retains its original shape. When bent more forcibly, the blade may not spring back again, but does not lose its original elasticity after straightening again.

Making Electric Steel for Roller Bearings



Methods of Operating Heroult Electric Furnaces, Forging the Ingots, Rolling the Billets, and Cold-drawing the Steel into Solid Bars and Seamless Tubing

By EDWARD K. HAMMOND, Associate Editor of MACHINERY

IT is a matter of general knowledge that the great demand for raw materials required by American manufacturers to enable them to execute orders for munitions and other war supplies that were received from the combatant nations of Europe, led to an unprecedented scarcity even prior to the time when our own country entered the war and began placing vast orders for military supplies and equipment. At this time, all kinds of steel commanded an excessively high price, and it was very difficult to obtain. Under these abnormal conditions, many manufacturers found it difficult to provide for their requirements, and in the following article a description will be published of how the Timken Roller Bearing Co., of Canton, Ohio, set about the solution of the problem of providing steel which is the essential raw material required in the production of its product.

Up to 1915 this firm had been buying the steel tubing and solid steel bars which are used in making the raceways and rollers for different sizes of bearings, but about three years ago these materials became so hard to buy, and deliveries were so uncertain that some form of relief from a constant source of trouble became imperative. The first step taken in this direction was to install a completely equipped rolling and drawing mill in the plant, which was done in 1915, in order to make it possible to purchase steel billets and skelp from the steel mills and do the remaining work of rolling and drawing the material at the Timken plant. The advantage of this plan lay in the fact that steel mills having their books overburdened with orders for finished bars and shapes were able to supply skelp (pierced billets to be used in manufacturing seamless tubing) and solid billets on rea-

Fig. 1. Pouring the Small Test Ingot taken from Furnace for Chemical Analysis

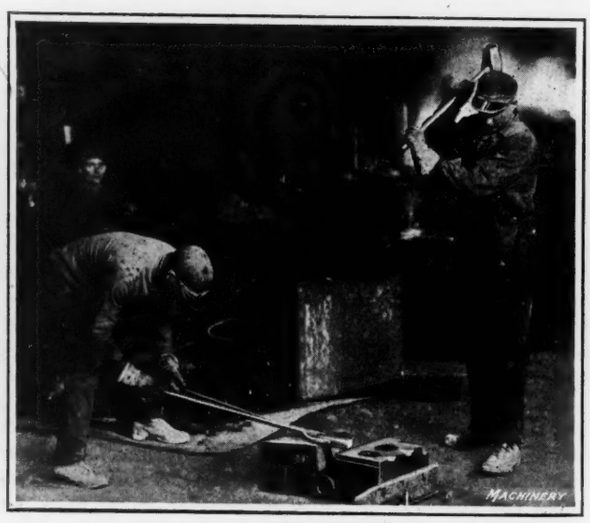


Fig. 2. Breaking Test Ingot to ascertain Carbon Content by Appearance of Fracture

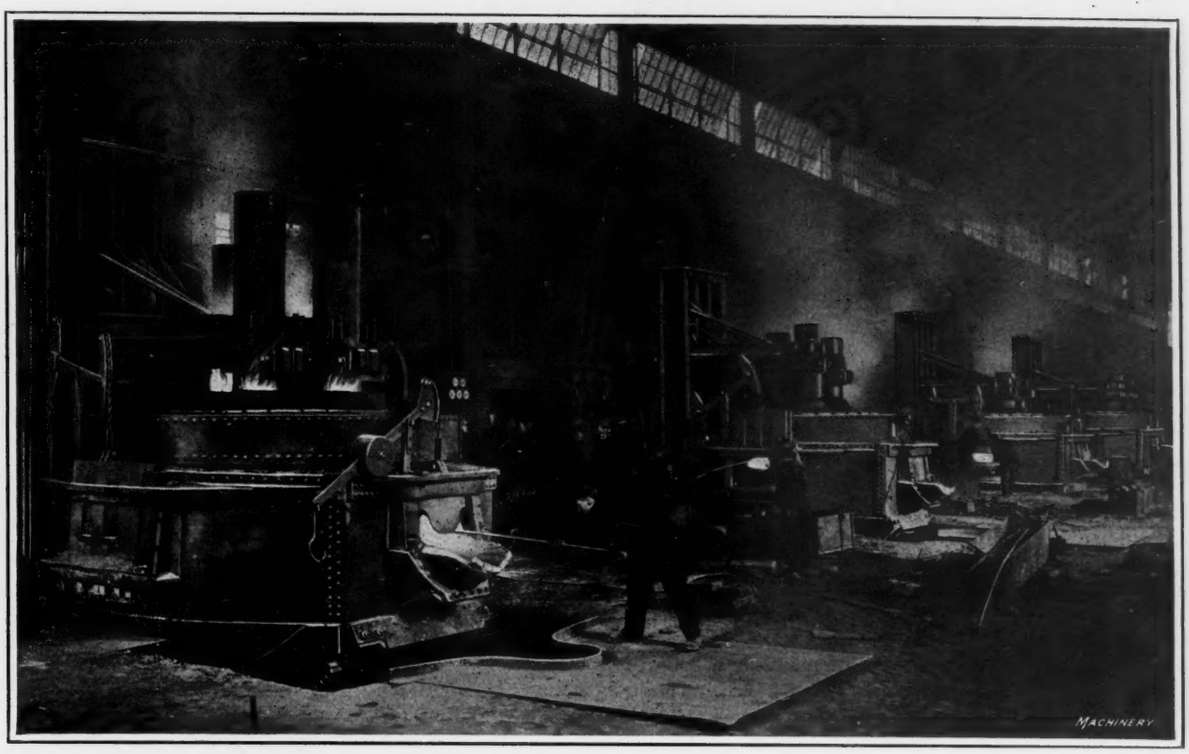


Fig. 3. Battery of Four Six-ton Heroult Electric Furnaces used in the Timken Roller Bearing Co.'s Plant for refining All Steel used in making Rollers and Races of Roller Bearings

sonable deliveries, when they could not give the same service on finished bars and tubing. This plan afforded great relief for a period of about one year, but then the congestion of the steel industry had become so much worse that the Timken management foresaw it would soon be no longer possible to get prompt deliveries on the skelp and billets.

Advantages of Electric Steel for Roller Bearing Construction

This condition necessitated further action in solving the steel problem, and the means finally adopted consisted of the installation of four six-ton Heroult electric furnaces in which steel could be made to supply the rolling and tube mills that were already in operation in the Timken plant. Several factors were responsible for the decision to use electric furnaces for making the steel instead of putting in some other well-known type of steel-making furnace. Chief among these was the fact that a particularly dense close-grained steel is required in making the parts of roller bearings, in order that they may give satisfactory service. It is estimated that electric steel is approximately 10 per cent more dense than steel made in other types of furnaces. In starting to consider the problem of installing this steel-making plant, engineers of the Timken Roller Bearing Co. looked over the industrial field as it exists today and realized that it would be feasible to purchase a sufficient quantity of chips and other scrap steel produced in munition plants to form the basis of all the steel required for the production of the Timken roller bearings which are being widely used in building motor trucks for military service, pleasure and commercial motor cars, and for a great variety of other purposes. The important factor in this decision is that although deliveries on finished steel are now very slow and uncertain, no particular difficulty is likely to be experienced in the purchase of the chips produced in manufacturing shells and other munitions. Hence, the problem was narrowed down to securing a force of experienced men to operate the steel-making equipment satisfactorily after this point had been reached.

In the August and September numbers of MACHINERY there were published two articles, "Electric Steel," by Franklin D. Jones, in August, and "Electric Steel-making," by Arthur V. Farr, in September. The first of these articles discussed the increased application and scope of electric furnaces in steel-making, and after presenting a general outline of prin-

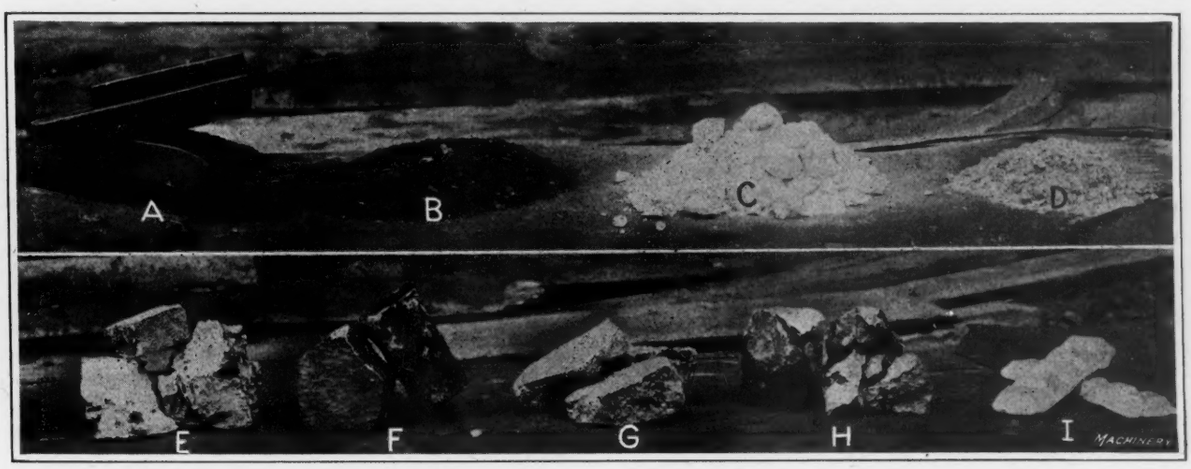


Fig. 4. Raw Materials used in making Electric Steel. A, Scrap Iron; B, Powdered Coke; C, Lime; D, Fluor-spar; E, Ferro-chromium; F, Washed Metal; G, Ferro-silicon; H, Ferro-manganese; I, Aluminum

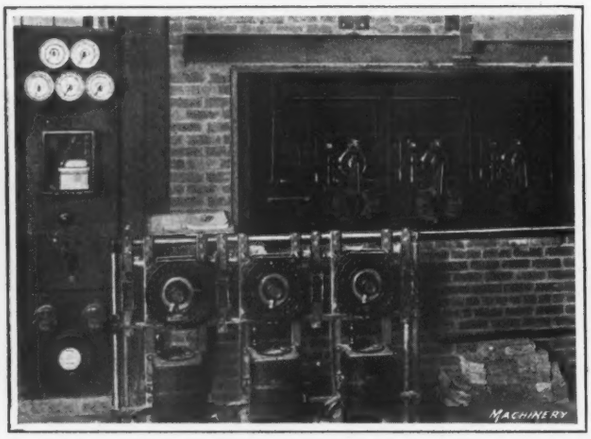


Fig. 5. Electrical Control Apparatus used in Connection with Heroult Electric Furnaces

ciples governing the operation of the electric furnace, detailed descriptions were given of different types of electric furnaces which are now in general use. The second article covered somewhat the same field, but dwelt in more detail upon the principles involved in charging and operating electric furnaces, and the properties of the finished steel. The publication of these two articles makes it unnecessary at this time to enter into detailed description of the Heroult electric furnace or the basic principles upon which it operates; it is the intention of the present article to describe the routine work of operating a battery of four of these furnaces at the Timken plant to provide for making the necessary quality and quantity of steel that is needed to meet the daily requirements of this great industry.

Purpose of Electric Furnace Treatment

In order for steel to possess the desired physical properties it is important that it contain the proper percentages of such elements as carbon, chromium, manganese, silicon, sulphur, phosphorus, etc. Without going into a detailed description of the influence exerted by each of these constituents, it will doubtless suffice to say that the effect of manganese, chromium, and silicon is what might be called "constructive," because it gives the steel desirable physical properties; and conversely, the effect of sulphur and phosphorus is "destructive," because these chemical elements when present in the steel deduct from its strength, ductility, etc. Hence, it is of vital importance to carry on the process of steel manufacture in such a way that the required percentages of certain elements are present and that the percentages of other elements are reduced to a safe maximum limit. It is for this reason that the process of refining in an electric furnace or in any other form of furnace is conducted. In operating electric furnaces there are two general methods of procedure, one of which is to deliver a molten charge of Bessemer or open-hearth steel into the electric furnace ready for the refining operation to be conducted, and the other is to add the constituents of the furnace charge in a solid condition, the latter being known as the "cold melt" process; and it is this process that is used in the steel-making plant of the Timken Roller Bearing Co.

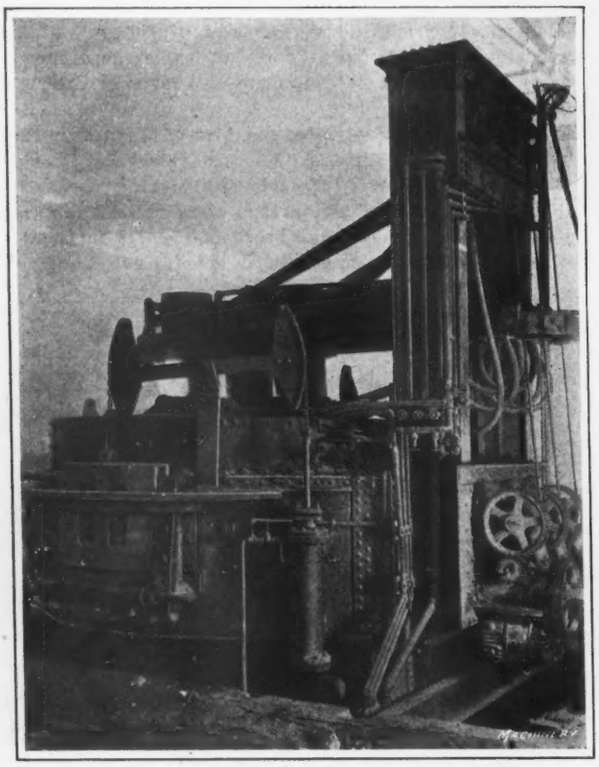


Fig. 6. Close View of Electric Furnace, showing Mechanism for tilting the Furnace and opening or closing the Charging Door

Constituents of the Electric Furnace Charge

Constituents of the preliminary charge for an electric furnace consist of some form of iron or steel, to which are

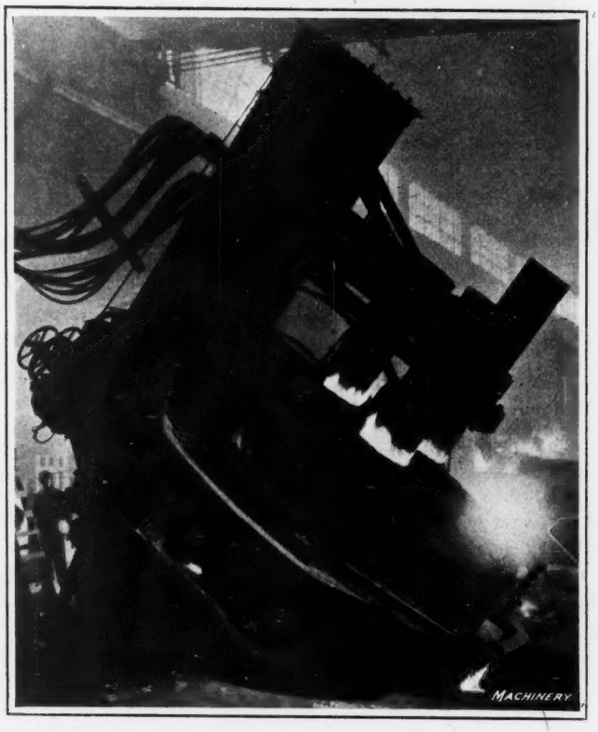


Fig. 7. Electric Furnace tilted forward to provide for pouring off the Slag

added materials that will combine with iron oxide to form a slag that lies over the metal in a molten condition, and by excluding the air prevent excessive oxidation. In carrying on the process it takes about three and one-half hours to charge the furnace and bring the metal into a molten condition, after which it is kept at the proper temperature for two and one-half hours in order to complete the refining process. In carrying out this process of steel-making, the first step after the steel has reached a molten condition and has become covered with slag is to remove practically all elements which are present in the iron, such as manganese, chromium, carbon, silicon, sulphur, and phosphorus, by the combined action of oxidation and absorption by the slag; then after all of these constituents have been eliminated, leaving practically pure iron, the necessary percentages of carbon, chromium, etc., are added to the molten metal in order to provide for securing exactly the proper percentage of each to give the steel the desired properties of strength, durability, etc.

A little thought will make it apparent that certain desirable constituents of the steel are removed and more material

has to be added in order to replace these constituents, which, of course, has the appearance of being wasteful and poor manufacturing practice. It is generally believed by steel-makers, however, that this state of affairs is unavoidable owing to the necessity of removing all but slight traces of sulphur and phosphorus from the molten metal. Unfortunately, the removal of these two constituents also involves taking out from the iron, carbon, chromium, manganese, and other constituents which give the steel valuable properties; and so far as present experience goes, the only way to obtain these properties in their entirety is to first remove the undesirable elements, taking certain desirable constituents of the steel with them, and then replace these constituents, adding exactly the most desirable percentage of each.

Function of the Refining Process

Referring to Fig. 4 there will be seen the various constituents of the charge for an electric furnace as operated at the Timken plant. These constituents are as follows: *A*, scrap iron; *B*, powdered coke; *C*, lime; *D*, fluor-spar; *E*, ferro-chromium; *F*, washed metal; *G*, ferro-silicon; *H*, ferro-manganese; and *I*, aluminum. The purpose of these different constituents is as follows: Iron is the basis or body of the steel from which all but slight traces of impurities are first removed during the process of refining. Fluor-spar and lime are added to the furnace charge (sometimes adding iron ore with them) in order to produce a slag over the metal which will prevent it from excessive oxidation and facilitate the removal of impurities. Ferro-manganese, ferro-silicon, ferro-chromium, and powdered coke are added in a process known as "recarburizing" in order to restore the percentages of manganese, silicon, chromium, and carbon which it is required to have present in the finished steel. In order to attain this result, the charge of material placed in the furnace is carefully calculated in such a way that the addition of each of the constituents of the charge, to which reference has just been made, will result in bringing the final composition of the steel to exactly the required point. "Washed metal" is a name given to cast iron from which all traces of sulphur have been removed. This metal is added when it happens that the additions of other constituents have resulted in making the steel contain too high a percentage of certain of the elements to which reference has been made. Aluminum plays no constructive part in the process of steel-making, but experience has shown that as the molten steel is poured out of the furnace, the addition of a small quantity of this metal to the contents of the ladle serves to "quiet" the steel; that is to say, it prevents it from bubbling and giving trouble through failure to produce solid ingots.

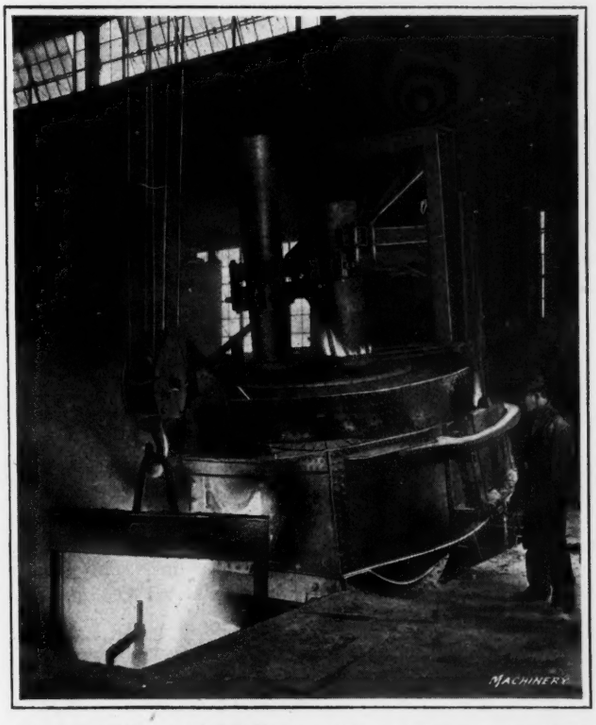


Fig. 8. Pouring the Molten Steel into a Ladle Ready for casting Ingots

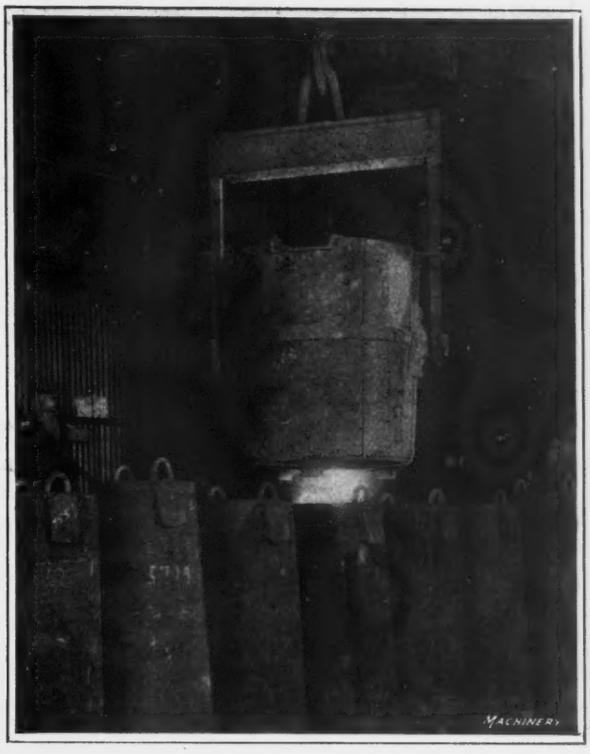


Fig. 9. Casting the Ingots. The Ladle holds Six Tons of Steel and its Contents produce Two Three-ton Ingots

It will, of course, be obvious that the constituents of the furnace charge are weighed out with the idea of adding the necessary percentage of each constituent to give the desired final composition for the steel. The way in which the routine process of melting is carried on is as follows: Scrap

Fig. 10. Forging Ingot under a 600-ton Hydraulic Hammer. This Hammer is served by a Manipulator which holds the Ingot

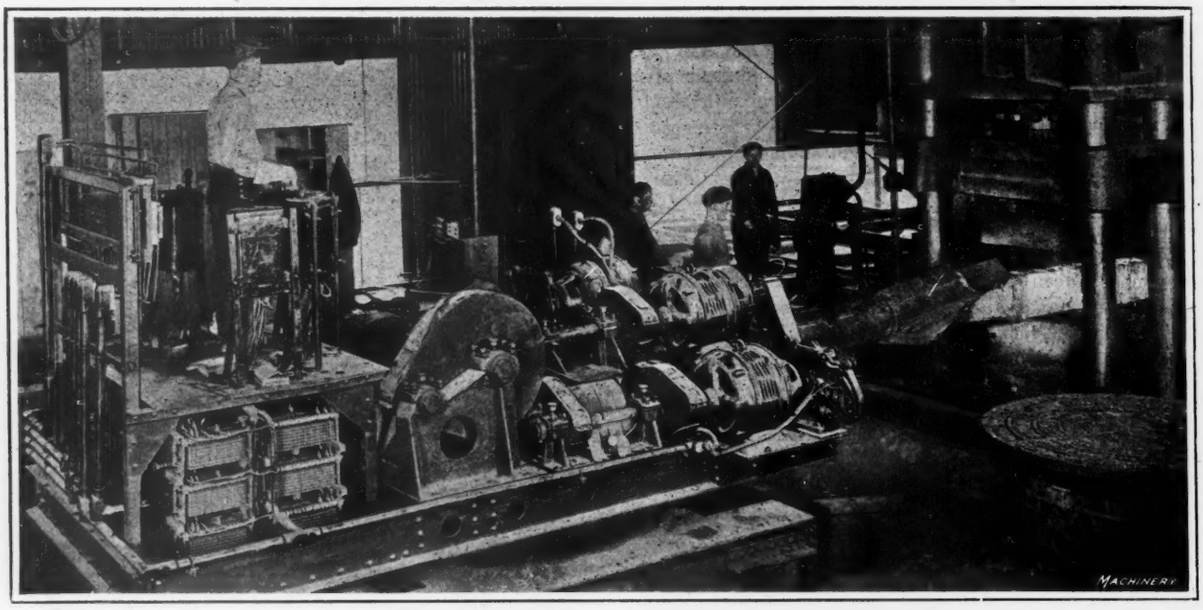


Fig. 11. Close View of Bed of Hydraulic Hammer and Manipulator shown in Fig. 10. This Manipulator provides Both Lateral and Rotary Movement of the Ingot for forging it into a Bar

iron, steel chips, and limestone are placed in the furnace and current is turned on. It takes approximately one-half hour to complete charging, and at the expiration of, roughly, three and one-half hours, the charge is completely melted. Ordinarily, a slag is formed through a chemical reaction taking place between the limestone and rust on the iron, but in the event of failure to obtain the desired results in this way, additional iron oxide is added in the form of iron ore. After the charge has been in the furnace for about four hours, the furnace is tipped forward to provide for pouring out what is known as the "oxidizing slag" which is black in color. By this time the foreign constituents in the iron have been removed by oxidation or absorption in the slag. Then the metal is recarburized by adding the necessary percentages of carbon, ferro-manganese, ferro-silicon, ferro-chromium, etc., after which additional lime, fluor-spar, and powdered charcoal are added to produce what is known as a "deoxidizing slag" that is white in color, because it is free from the presence of metallic oxides. This slag protects the metal from further oxidation and enables the contents of the furnace to be maintained in a molten condition to facilitate the thorough assimilation of the constituents which have been added.

Time Required to Refine the Steel

After a total period of six hours in the furnace, or roughly, two hours after the recarburizing material has been added, the charge is ready to pour. Shortly before pouring, a test ingot is taken from the furnace in a ladle and broken in order that its fracture may be examined to estimate the percentage of carbon, which can be done with a surprising degree of accuracy by men of wide experience in steel-making. This test ingot is then sent to the chemical laboratory in order that it may be analyzed to ascertain beyond doubt that the required composition has been obtained for the steel before it is poured from the furnace. The finished steel must be of approximately the following composition. For roller bearing cups and cones the steel contains 0.20 per cent carbon, 0.50 per cent manganese, 0.12 per cent silicon, not over 0.02 per cent phosphorus, and not over 0.025 per cent

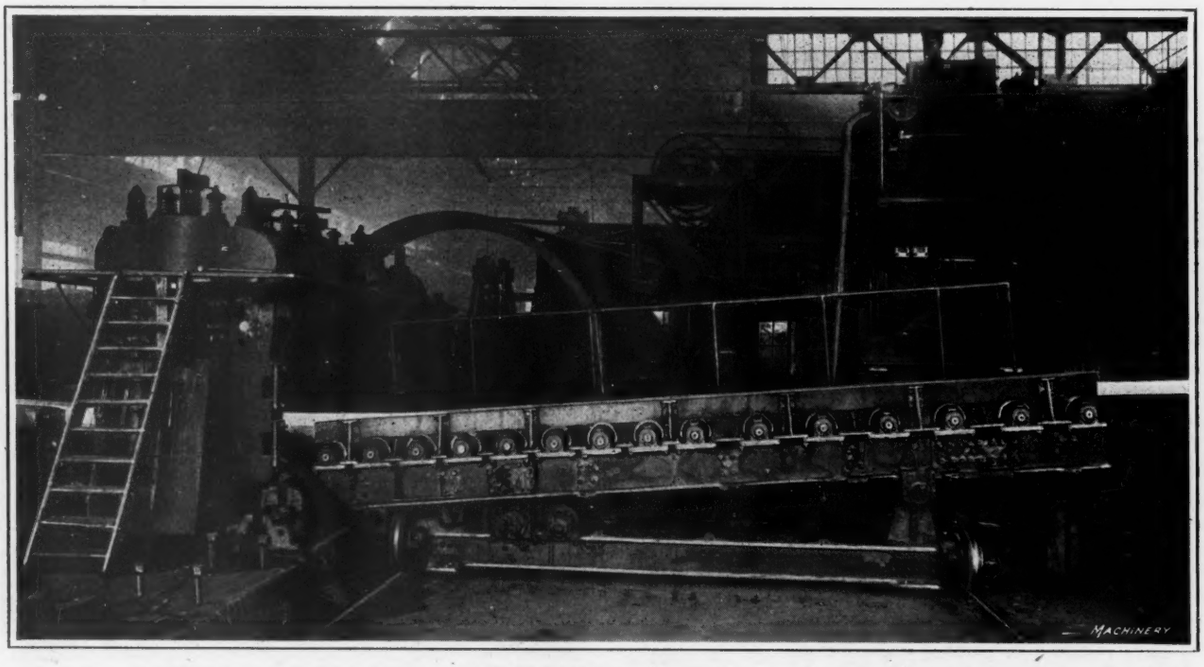


Fig. 12. Heated Billets are pushed onto this Tilting Table which facilitates the Work of passing them back and forth through a Three-high Rolling Mill

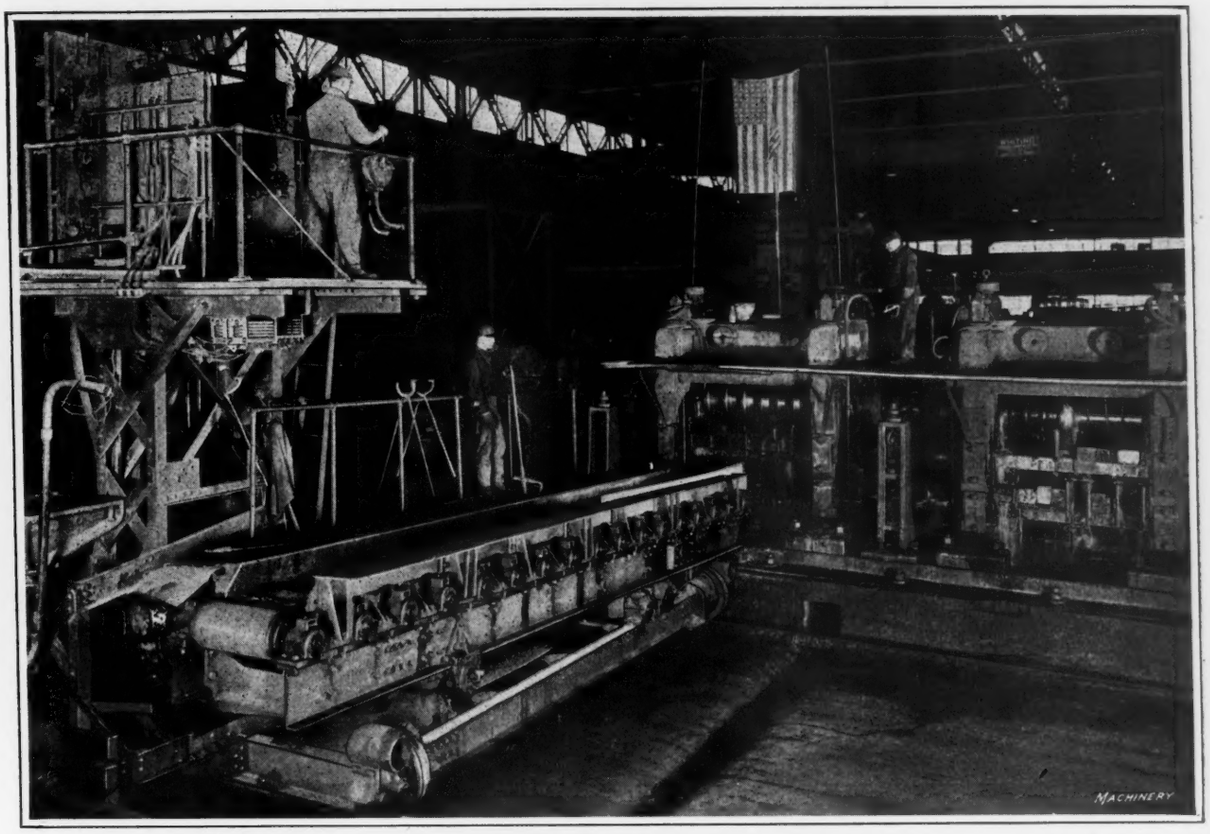


Fig. 13. Close View of Tilting Table at Opposite Side of Rolling Mill. The Table can be tilted to any Desired Position, and its Support can be moved along the Tracks to reach any Desired Pass in the Mill

sulphur. Steel used for making rollers has approximately the same composition except that there is also present 1 per cent of chromium. The four furnaces have a capacity for turning out 96 tons of steel in a twenty-four-hour working day. They can be run for a week after which they are shut down to be relined on Saturday afternoon or Sunday.

Pouring the Ingots

Steel which has been refined in the electric furnaces is first poured into a ladle and from this ladle it is poured into what are known as "ingot molds," in which the metal is allowed to solidify ready for the performance of subsequent steps in the process of manufacture. Each of these ingots weighs three tons, and particular attention is called to the fact that the ingots are made small at the bottom so that they solidify first there, freezing proceeding gradually from bottom to top, with the result that impurities are carried upward. This practice is the reverse of that generally employed in open-hearth steel mills, where the ingots are larger at the bottom than they are at the top, and freezing proceeds downward. Molds of the latter form were originally used in the plant of the Timken Roller Bearing Co., but it was found difficult to produce steel of the required composition when the molten metal was cast in them. After pouring the steel into the ingot molds and giving it sufficient time to solidify, the next step is to strip off the molds, which

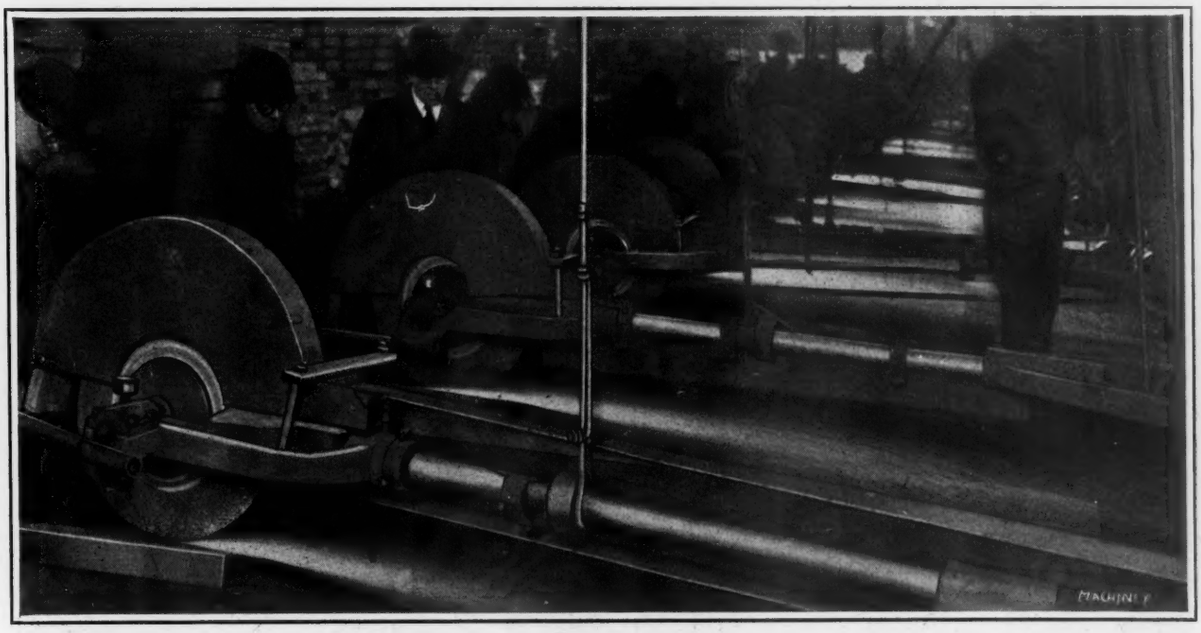


Fig. 14. Removing Surface Defects on Roller Steel Bars by Grinding. If they were not removed, Such Defects would be carried through the Process and show on the Surface of the Finished Steel

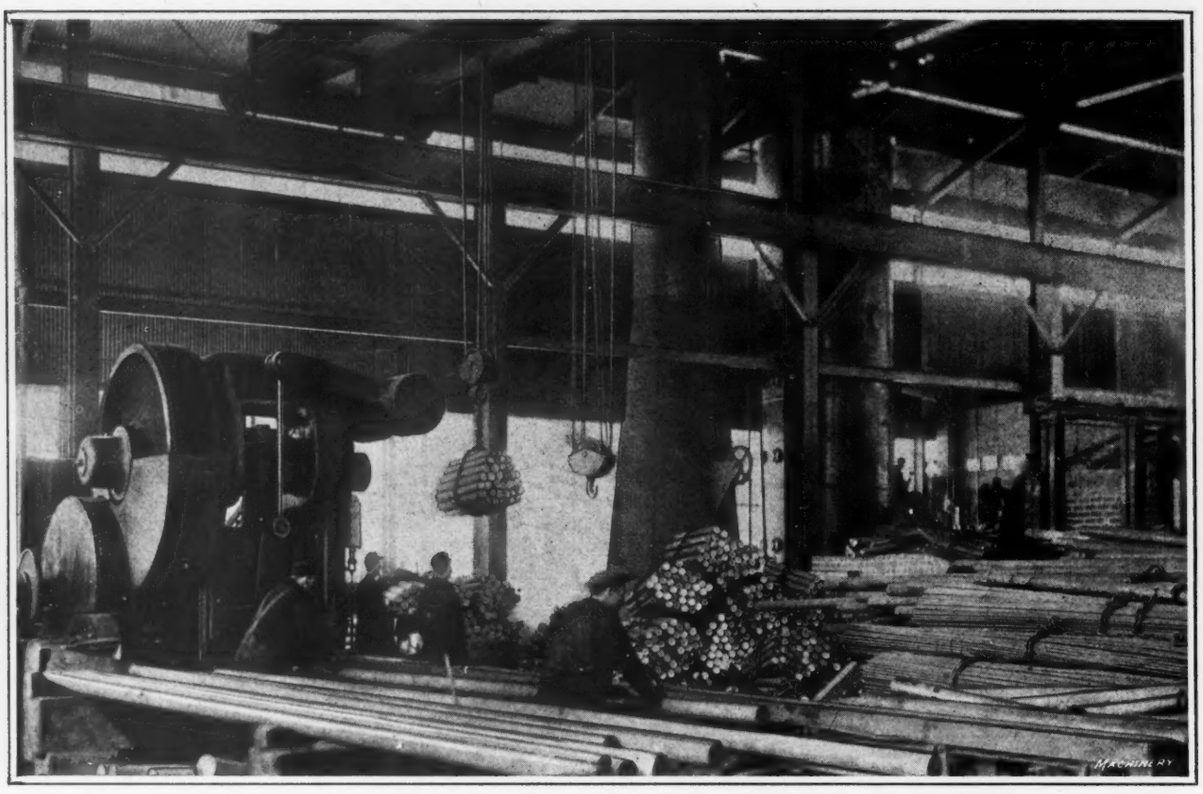


Fig. 15. Cutting up Rolled Bars into Billets of Suitable Length to be worked in the Piercing Machine

is done by a special hydraulic press. This consists of two hooks which obtain a grip on lugs at each side of the mold, and a plunger which rises into the bottom of the mold and pushes out the ingot.

After being removed from the molds, the ingots go to two two-hole soaking pits which are heated by reverberatory furnaces arranged to reverse every twelve minutes. In this connection it may not be out of place to state that the reverberatory furnace is a device arranged to preheat the mixture of gas and air consumed in a furnace before combustion of the gas actually starts. By preheating in this way, it is possible to obtain a higher temperature than would otherwise be the case. Preheating is accomplished by having a checkerwork built of firebrick, through which the mixture of gas and air is drawn before entering the combustion chamber. The hot products of combustion leave the furnace and escape through a similar checkerwork arrangement at the opposite side of the furnace, thus raising its temperature to a red heat. At the expiration of twelve minutes the direction of circulation is reversed so that the gas and air are drawn in through the checkerwork which has just had its temperature raised, and the products of combustion escape from the furnace by way of the checkerwork through which the gas was previously drawn, thus raising its temperature ready

Fig. 16. Close View of Special Mannesman Piercing Machine with Hydraulic Attachment for withdrawing the Piercing Mandrel from the Billet

Fig. 17. Cold-drawing Hot-rolled Seamless Steel to accurately size the Outside and Inside Diameters and impart a Bright Finish to the Steel

for the next reversal. Either oil or natural gas can be used as fuel in these furnaces, and the ingots are heated for four hours to bring their temperature to a uniform forging heat.

Forging the Ingot into Billets

After the ingots have been brought to a uniform forging temperature in the soaking pits, they are taken to a hydraulic forging hammer built by William Todd & Co., of Youngstown, Ohio, which exerts a pressure of 600 tons. This hammer has a capacity for turning out about 100 tons of steel billets in twenty-four hours, when served by a "manipulator" of the type built by the Morgan Engineering Co., of Alliance, Ohio. This manipulator, which is shown in operation in Figs. 10 and 11, turns the ingot and moves it laterally to provide for gradually forging the ingot out into a bar that can be cut up into billets of the desired size. The manipulator does the work of six men. After the forging operation has been completed, the steel goes through a gas- or oil-heated furnace of special design, in which the ingots are arranged crosswise on water-cooled slides. The furnace is approximately 50 feet long and the billets are pushed along the slides by means of a mechanical ram. They move progressively through this furnace, and the temperature and rate of travel of the steel have been so adjusted that by the time a billet reaches the opposite end of the furnace from that at which it entered, it is ready to be passed on into the rolling mill. The billets are pushed out through a door of the furnace onto a tilting table which leads to a three-high rolling mill. This tilting table is shown in Figs. 12 and 13, from which it will be seen that there is one table at each side of the mill. The function of the tilting mechanism is to raise or lower the surface of the table, so that the billet or bar may be first passed through the upper set of rolls and then through the lower, this operation being continued until the bar has been reduced to the desired diameter, after which it is straightened and allowed to cool.

Inspecting the Rolled Bars for Surface Defects

The bars which have been produced by rolling may be used for either of two purposes; they may be rolled out into solid bars of smaller diameter and given a final finish by cold-drawing, in order to adapt the stock for use in automatic screw machines, or the bars may be cut up into short lengths and pierced to convert the material into what is designated as "skelp," which is used in making seamless steel tubing. Regardless of the purpose to which the rolled

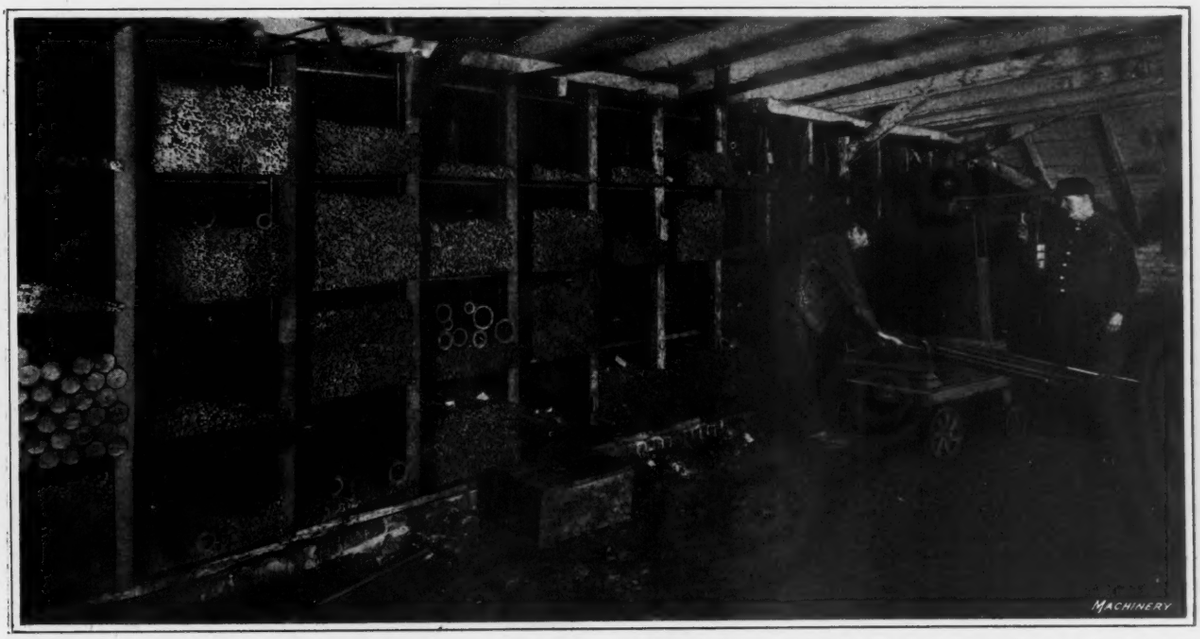


Fig. 18. One of the Racks filled with Finished Seamless Steel Tubing and Solid Bars produced in Steel Mill of the Timken Roller Bearing Co.

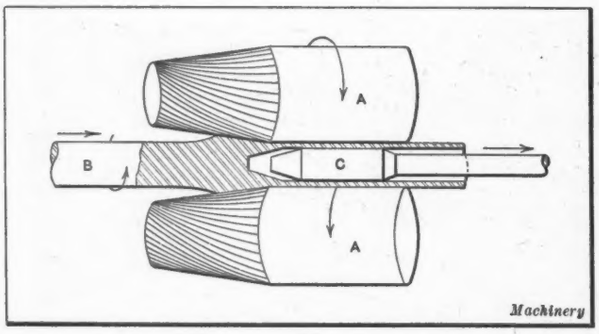


Fig. 19. Diagram illustrating Principle on which Mannesman Billet Piercing Machine operates. Feed-rolls A push Billet B over Piercing Mandrel C

steel bars are to be put, it is necessary for them to be free of all surface defects, because such imperfections, caused by the presence of any seams or slag imbedded in the steel, would be carried right on through the process and show in the finished material. On this account, each bar of steel which is rolled in the Timken plant is subjected to a careful inspection, and the men who do this work direct the use of either pneumatic chipping hammers or grinding machines, which can be used to remove any surface defects that are discovered.

Making Seamless Steel Tubing

Bars to be employed in making seamless steel tubing are sheared into three- to four-foot lengths and examined at each end for the presence of "pipes" or other structural defects in the steel, this work being done by a representative of the metallurgical laboratory. These short bars are then placed in a continuous heating furnace, fifty feet long, in which they are slowly rolled down firebrick ways by gravity. It will also be of interest to note that the furnace is heated by gas or oil and that the hot products of combustion are carried up through a Wickes boiler which enables a large part of the heat otherwise carried away by smoke and gases to be recovered. After being raised to a forging heat, the bars are withdrawn from the furnace, one at a time, and placed in a billet piercing machine built by William Todd & Co., this being a special modification of the Mannesman piercing machine which was designed by R. E. Brock, superintendent of the Timken steel mill, to meet the peculiar requirements of that plant. The features of the machine are that the angle of the rollers that feed the billets into the piercing machine can be varied according to the size of the billets or the physical properties of the steel to be pierced; or the direction of rotation may be reversed to provide for drawing the tube back off the piercing mandrel.

In operating this billet piercing machine, the method of procedure is as follows: A heated billet is taken from the furnace and placed between two serrated feed-rolls on the machine, which are mounted at a slight angle to each other. Owing to this angle, the rotation of a billet between the rolls results in also advancing the billet so that it is fed through the machine. This idea will be best understood by referring to the diagram Fig. 19, which indicates the way in which the feed-rolls run. As the billet is fed through the rolls, it is forced over a piercing mandrel, with the result that the solid billet is converted into a seamless tube which bears the trade name of "skelp." Obviously, the tube is firmly fixed over the piercing mandrel on the machine, and mention has already been made of the fact that the tube may be drawn off the mandrel by reversing the direction of rotation of the rolls. It is found more economical, however, to have the piercing mandrel connected to a piston in an air cylinder, which is employed to pull back the mandrel, thus withdrawing it from the work. Care must be taken to withdraw the mandrel promptly after it has pierced the billet, before the steel has had time to cool and shrink onto the mandrel, as it would then be impossible to pull the mandrel out of the billet.

Rolling and Drawing the Tubes Down to Size

After the billet has been pierced, it is transferred (while still at a red heat) to a rolling mill provided with rolls having the successive passes so proportioned that the outside and inside diameters and wall thickness of the tube are steadily reduced, with a corresponding increase in length. By this process of rolling, the tube is brought very nearly to its final form, and after being pickled in sulphuric acid to remove oxide scale, the final process consists of cold-drawing the tube through a die in order to size the inside and outside diameters and wall thickness, and to impart to the surface of the steel a bright polished finish. An ordinary draw-bench is employed for the performance of this operation, but in order to size the inside diameter of the tube, a mandrel is employed which is slipped through the tube to reach a position inside of the opening in the die. The mandrel is made of hardened tool steel, and a rod threaded into the mandrel extends out from the back end of the tube so that it can be anchored to the base of the machine to hold the mandrel stationary while the tube is being drawn. In preparing to perform the drawing operation, the front end of the tube is pointed so that it can be threaded through the die and gripped by the tongs on the draw-bench; then the inside-diameter sizing mandrel is pushed through the inside of the tube and the rod secured to the back end of this mandrel is anchored in place. The drawing operation can then be conducted in the same way as for a solid bar, and it imparts to the steel the same advantages which have been explained in MACHINERY in connection with articles describing the processes of cold-drawing and cold-rolling steel. It is possible to obtain a reduction in diameter of about 1/16 inch at a pass, which is much more than in the case of solid tubing, because of the greater flexibility of the material. After each two passes, the steel has to be annealed to remove internal strains.

Straightening the Drawn Bars

Bars of steel which are drawn through a die are usually considerably distorted by the process, even though they were perfectly straight before the drawing operation was performed. It is necessary to bring the material back to a straight condition before it is placed in storage, and for this purpose the Timken plant is equipped with a straightening machine built by the Abramsen Engineering Co. of Pittsburg, Pa. This machine is provided with two pairs of concave rolls which are staggered in relation to each other. The bar to be straightened is passed between these two sets of rolls, and as a result of the concavity and staggered arrangement, it comes out perfectly straight. The finished material is then placed in storage racks ready for delivery to the manufacturing departments as fast as it is required.

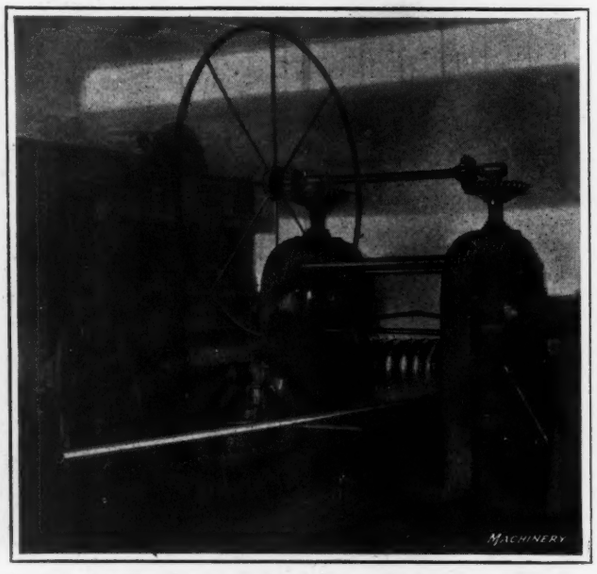


Fig. 20. Rolling the Pierced Billets out into Seamless Tubing

TIME-STUDY CARD

Catalogue No._____

Name of Part_____ Material for_____ Pieces

Material_____

OPER. NO.	DESCRIPTION OF OPERATION	SET-UP TIME	AVERAGE RUNNING TIME	SPINDLE SPEED	TABLE FEED	MACH. CLASS	CODE NO.	TIME LOST FOR INSPECTION	REMARKS	DATE OF TIMING

Fig. 1. Time-study Card

LAY-OUT AND PIECE-RATE CARD SYSTEM

FORMS THAT ASSIST IN EFFICIENT SHOP MANAGEMENT

BY JOHN J. BORKENHAGEN

Piece-rate Inspector, Independent Pneumatic Tool Co., Aurora, Ill.

EFFICIENCY in shop management depends on the system used in laying out the work and the setting of the piece rate. The system shown here has proved very satisfactory; some of the forms are printed on cards of different colors, so that they can be readily identified. The first form, shown in Fig. 2, gives a list of the machine tools in the shop and the symbol by which each tool is designated in the lay-out system. For instance, a 14-inch lathe is designated as B, so if this lathe is to be used on a certain piece of work the lay-out will state that the work is to be handled on a Class B machine. It is well to make this form up on a piece of tracing cloth so that a blueprint may be quickly made whenever wanted.

MACHINE CLASS LIST

NAME OF MACHINE	SIZE	MAKE	CLASS
Acme automatic	1″		A
Gridley automatic	3″		A-1
Cleveland automatic	2″		A-2
Brown & Sharpe automatic	#0 & 00		A-3
Lathe	14″ swing		B
Milling machine			C
Single-spindle drilling machine			D
Two-spindle drilling machine			D-1
Three-spindle drilling machine			D-2
Four-spindle drilling machine			D-3
Punch press			E
Shear			F
External grinder			G
Internal grinder			G-1
Bench grinder			G-2
Thread milling machine			H
Hand screw machine	1″		I
Hand screw machine	1⅛″		I-1
Hand screw machine	2″		I-2
Jones & Lamson turret lathe			J
Vertical milling machine			K
Boring mill			L
Gear-hobber			M

Fig. 2. Classification of Machine Tools

The heat-treatments for the various steels used are recorded and designated by code numbers, one of the cards used for this purpose being shown in Fig. 3. These cards give the heat figures, method of handling, etc. Different colored cards should be used for different treatments; a good plan is to have a red card for hardening, a blue card for carburizing, etc. This card system is used in connection with the regular lay-out system, which designates the heat-treatment to be used only by the code number. For instance, if the lay-out says "Harden, Code No. 13," it means that the piece is to be hardened according to the method described on card No. 13. This card system should be kept up by the metallurgist of the plant and cards made of each treatment for both the lay-out department and the smith shop.

In Fig. 1 is shown a time-study card. When a new piece of work comes into the plant the drafting department sends a blueprint of the work to be done to the lay-out and piece-work department. This department then divides the work into the separate operations by which it can best be handled. The description of each operation is typewritten on the time-study sheet and turned over to the time-study man, who takes a certain number of pieces into the experimental department so that each operation may be timed and a permanent rate set before the work is turned into the shop. After each operation has been timed, the regular lay-out is made up and cards made for the production, cost, inspection, pay-roll, rate, and lay-out departments, as well as all shop cards.

Fig. 4 shows the lay-out card issued to the production department. This card, which is ruled on both sides, gives the catalogue number, name of part, material to be used, the quantity required for a certain number of pieces, and what departments are to work on each operation. The catalogue number is the number of a part shown in the company's catalogue. For example, catalogue number PD-2-68 is the number used in the catalogue to classify a valve. The PD stands for "Pneumatic Drill," the No. 2 stands for the size of the drill or assembled tool, and the No. 68 stands for the catalogue

CODE NUMBER FOR HEAT-TREATMENT OF STEEL

Code No._____

Material
HARDENING. DESCRIPTION

Fig. 3. Heat-treatment Record

DEPARTMENT Catalogue No._____

Name of Part_____

Material_____ Material for_____ Pieces_____

OPER. NO.	DESCRIPTION OF OPERATION	DEPT. NO.

Fig. 4. Lay-out Card for Production Department

DEPARTMENT ORDER TRACER

Order No._____

Department No._____ Date_____

Operation to be Performed _____

Quantity _____ Pieces Catalogue No._____

Name of Part_____ Date Due_____

RECEIPTS						DELIVERIES					
DATE	FIN.	NO. OF PIECES	DATE	FIN.	NO. OF PIECES	DATE	NO. OF PIECES	FIN.	DATE	NO. OF PIECES	FIN.

Sign this tracer when final delivery is made and return to Cost Department

Above O.K._____ Foreman

Fig. 5. Front of Department Order Tracer

POST WORKMEN'S TIME ON THIS SIDE

Order No._____

OPER. NO. _____					OPER. NO. _____					OPER. NO. _____				
CLOCK NO.	DATE	NO. PC.	TOTAL FIN.	HRS.	CLOCK NO.	DATE	NO. PC.	TOTAL FIN.	HRS.	CLOCK NO.	DATE	NO. PC.	TOTAL FIN.	HRS.

REMARKS

Fig. 6. Back of Department Order Tracer

number of the part. All parts which are assembled into the complete drill, are given separate numbers, so a customer may order repair parts by their given number. If a customer wishes to replace a live air handle valve, he writes for part No. 68 for a No. 2 drill. This part is looked up and the catalogue shows that the customer wants the part designated as PD-2-68. From this card the production department obtains its information for the department tracers that are reproduced in Figs. 5 and 6. When an order is issued by the production department, a notice is sent to the cost department, which makes out a cost sheet showing the catalogue number, order number, amount of order, and the date on which the card is issued. At the same time the raw-stock room is ordered to send the material to the department doing the first operation. Then a department tracer is made up showing the operations each department must complete and on which they must keep their time.

The department tracer, Figs. 5 and 6, shows the number of pieces to be made, the catalogue number, the order number, the pieces received, and the pieces delivered. On the back, the tracer shows the time, the employe's clock number, date, and total number of pieces finished.

When an operation is finished and the lay-out shows that the next operation is to be done in another department, the clerk or foreman makes out in duplicate the delivery ticket shown in Fig. 7; these tickets are made up in book form.

DELIVERY TICKET

From Dept. No. To Dept. No.

Cat. No. Order No.

Pieces sent out_____

Operation finished_____

Pieces spoiled on last operation_____

Counted by_____

Inspected by_____

Delivery ticket made up by_____

O.K. by_____ Foreman

Fig. 7. Delivery Ticket

WORKMAN'S DAILY TIME CARD

Dept. No._____ Clock No._____

Order No._____

Man's Name_____ Date_____

Article Cat. No.

Operation

TIME STARTED	TIME FINISHED	OPER. NO.	FOR DEPT. NO.

PIECES	DAY WORK		AMOUNT	HOURS	PIECE-WORK		AMOUNT
	HOURS	DAY RATE			PIECES	RATE PER 100	

O.K._____ Foreman

Fig. 8. Daily Time Card

At the same time he enters on the front of the shop tracer, Fig. 5, the number of pieces that he sends out. The original delivery ticket is sent to the production department to show that the work has been delivered, and the duplicate is sent, with the work, to the clerk in the next department, who checks up the number of pieces received and records the number on his tracer.

The cost sheet shown in Fig. 9 should be made to fit in a loose-leaf folder; a sheet about 11 by 20 inches will be found a convenient size. When the cost department receives

COST SHEET

Date Issued_____ Order No._____

Name of Part_____ Catalogue No._____

Material_____ Amount of pieces in order_____

OPERATION NO.				OPERATION NO.				OPERATION NO.				OPERATION NO.				OPERATION NO.			
CLOCK NO.	PIECES	COST	DATE	CLOCK NO.	PIECES	COST	DATE	CLOCK NO.	PIECES	COST	DATE	CLOCK NO.	PIECES	COST	DATE	CLOCK NO.	PIECES	COST	DATE
TOTAL																			

Cost of Material_____ Cost of Labor_____ Total Cost_____ Pieces scrapped_____

Fig. 9. Cost Sheet which gives Total Cost of Material and Labor

Cat. No._____

Name of Part_____

Piece-rate card_____ Dept. No._____

OPER. NO.	DESCRIPTION OF OPERATION	DEPT. NO.	RATE PER 100	DATE OF TIMING

Fig. 10. Piece-rate Card

Name of Part_____ Cat. No._____

Material_____ Dept. No._____

OP. NO.	DESCRIPTION OF OPERATION	AVER. TIME	MACH. CLASS	RATE PER 100	TABLE FEED	SPIND. SPEED	DELIV. TO	DATE

Fig. 11. Machine Shop Card

notice that an order has been issued, it refers to its lay-out, which is similar to the production department card shown in Fig. 4, and writes the operation numbers in spaces left for this purpose on the cost sheet. Then, as the daily time cards are received, the employe's clock number, number of pieces done, cost, and date are entered. When the total time is received and the order is closed, the cost is made up from this sheet.

Fig. 8 shows the daily time card made out by the employe. This card shows the operation number, department number, name of article, number of pieces made, and time spent on work. A white card may be used for the day force and a blue card for the night. When the clerk receives this card, he checks it with the lay-out to see if the operation number and prices are right; he then enters them on his tracer and turns them over to the foreman of the department for his O. K., after which the cards are sent to the pay-roll department where the prices are rechecked with the piece-rate card. After the time cards have been rechecked and found to be correct, the time and money are posted by the timekeeper who then sends them to the cost department for entry on the cost sheet.

The piece-rate card shown in Fig. 10 is made in duplicate, one for the pay-roll department and one for the piece-rate department. This card gives the operation number, description of operation, department number, date, and rate per 100 pieces.

The machine shop card shown in Fig. 11 is made of a light-weight yellow cardboard and shows the catalogue number, department number, name of part, material, operation number, description of operation, average running time per piece, machine designation, rate per 100 pieces, feed of table, spindle speed, department to which completed work is to be delivered, and date on which piece rate was set. If the foreman does not know how to handle the speed or feed information or if the operator cannot make the number of pieces called for by the lay-out, the foreman informs the lay-out department and a demonstrator is sent to determine what the trouble is and if necessary to give the desired instruction.

Fig. 12 shows a lay-out card used by the inspection department. This card is somewhat like the production card, and both sides are ruled alike. In the space provided for that purpose, information is given the inspector as to gages, limits, and other details.

The smith shop card shown in Fig. 13 gives the name of the part, catalogue number, material, operation number, description of operations, code numbers for heat-treatment of steel, department to which completed work is to be delivered, and date on which piece rate was set. Like the machine shop card, this card is of light-weight yellow cardboard.

REPLATING BRITANNIA METAL

Partly worn articles made of Britannia ware must be chemically cleaned before they can be replated. The process is described in an article by Charles H. Proctor in *The Metal Industry*. The articles to be plated should first be immersed for a minute or two in a bath, heated to 160 degrees F., that is composed of eight ounces of sodium cyanide and one gallon of water, and then thoroughly washed with water. If the articles are smooth and free from scratches and the old silver remaining upon the articles is adherent, they may be cleansed with a soft bristle brush and again washed in water. The cleansing medium should be floated whitening mixed to a paste with water; a little cyanide may be added to prevent the surface of the metal from tarnishing. Old silver may be stripped from Britannia metal by using a cyanide electro-strip. The articles are then the anode and the sheet steel the cathode; the electrolyte is in the proportion of eight ounces of sodium cyanide to one gallon of water. The work should be hung between two sheets of steel so that in the stripping operations, the silver will be uniformly removed.

After the articles have been immersed for a minute or two in a solution consisting of one gallon of water and six ounces of caustic soda heated to 200 degrees F., and washed thoroughly with water, they are quickly placed in the silver strike solution. This solution consists of one gallon of water, six ounces of sodium cyanide, one-half ounce of silver cyanide, and one-fourth ounce of caustic cyanide. A silver anode is used, the temperature is normal, and the current is from three to four volts. Then the articles are plated until sufficient silver has been deposited, a new silver solution being prepared each time as follows: one gallon of water, five ounces of sodium cyanide, three and three-fourths ounces of silver cyanide, and one-fourth ounce of caustic soda. The anodes are fine silver, normal temperature is used, and the current is one volt. According to the amount of silver deposited the ware is known as single, double, triple, and quadruple plate. Triple plate has one ounce of metallic silver per square foot of surface.

The process of "quicking" Britannia metal consists in coating the cleansed surface with mercury to produce a more adherent coating. The solution used for this purpose consists of one gallon of water, one pound of sal-ammoniac, and two ounces of bichloride of mercury. The mercury salt is dissolved in a little boiling water and mixed with the sal-ammoniac. The articles are then washed in water and immersed in a cyanide bath to even up the surface and remove the grayish-black stains from the mercury, which sometimes develop in amalgamating Britannia metal. The silver striking is accomplished in the manner previously described.

Cat. No._____

Name of Part_____

Material_____

INSPECTION DEPARTMENT

OPER. NO.	DESCRIPTION OF OPERATION	INSPECTION REMARKS

Fig. 12. Inspection Department Card

Cat. No._____

Name of Part_____

SMITH SHOP CARD Material_____

OPER. NO.	DESCRIPTION OF OPERATION	CODE NO.	RATE PER 100	DEL. TO	DATE

Fig. 13. Smith Shop Card

Lens Grinding In a Training Factory

How the United States Government is Devising Means for Meeting War Emergencies

By ERIK OBERG

The Rochester Athenaeum and Mechanics Institute is one of the most progressive institutions of its kind in the country. The manner in which the work of the institute has been adapted to the needs of the nation in war time shows what can be done when practical needs rather than fixed curricula are made the determining factor in the development of an educational institution.

AT the beginning of the war the United States Army and Navy found themselves hopelessly short of optical instruments for observation and scout duty, and for the control of barrage artillery fire. Previous to the war, the annual production of binoculars in the United States was only a little over 4000 pairs a year. This supply, of course, was wholly inadequate to meet the needs of the military forces, and every factory in the country capable of producing optical instruments was called upon to rush the production of binoculars, range finders, periscopes, and other similar instruments. As a result, one factory alone is now required to turn out 5000 lenses a week, a production many thousand per cent greater than that previous to the war. This increase in production, of course, meant a need for more workers in the optical factories, and as the manufacturer of such instruments as mentioned requires help having a high degree of skill, particularly in the production of lenses, it was found practically impossible to secure trained help in sufficient numbers to supply the demand of the industry.

The Ordnance Department, realizing that the rate of production of finished instruments was determined by the number of lenses that it was possible to manufacture, procured through its Production Division an appropriation from Congress to establish a school for the training of precision lens grinders. Owing to the fact that the optical industry was so largely represented by the great factories located in Rochester, N. Y., the training school was equipped and opened at the Mechanics Institute at Rochester.

A Training Factory—Not a Training School

It is rather a misnomer to call this new department for the training of lens grinders a school. It is not a school—it is a training factory, because the product turned out will be a commercial product, and the workers are trained under purely factory conditions. The Mechanics Institute is in charge of the training factory under the auspices of the United States Government. The capacity of the training shop is for seventy-five men and women at one time. Women are trained mostly, but men over or under the draft age are also admitted. Applicants are placed directly in the training shop, and are paid during the period of training 20 cents per hour the first and second week, 22 cents the third and fourth week, and 24 cents the fifth and sixth week. The course is of six weeks' duration, and upon having completed this brief and intensive training, the operators are assigned to work in optical factories either in Rochester at 27 cents per hour or at other points. Those, for example, who have come to Rochester from other communities and who wish to return to work in their home communities will be placed at work there, provided the local industry can use their services. In fact, a number of those being trained have come from distant points to take the training and expect to return to their home towns to work in the optical factories there. In Rochester alone it is estimated that at least 500 trained lens grinders from the training shop can be absorbed in one year.

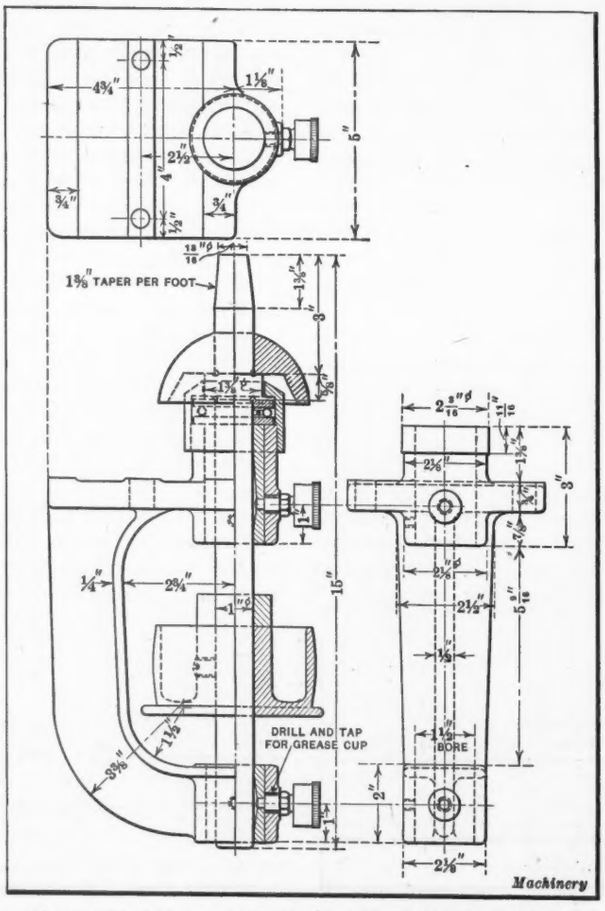


Fig. 1. Principal Parts of Machine used for grinding Optical Lenses

The operators, after completing their training, are placed in the factories at the commercial wage prevailing for the work that they perform. Untrained women workers, after six weeks' training, will receive about $12 per week as an initial wage, but skilled workers are paid according to their ability, and many are able to earn from $25 to $30 per week within a reasonable time. Wage remuneration alone, however, should not be the only consideration in entering this work, because at this time it is a patriotic duty for people to apply themselves to an industry such as this, which is of the greatest importance in the conduct of the war and without which our armies abroad would be unable to operate

efficiently. All applicants agree to stay in this work for at least six months after the completion of their training, and they, in turn, are assured of a wage of not less than 22 cents an hour when the training is completed, which wage will be raised according to ability.

Method of Running the Training Factory

The training factory is run like a shop. The working day is eight hours, with half a day on Saturdays. The operators are under the regular factory rules and system and factory discipline. The entire training shop has the atmosphere of a factory, timeclocks being punched and timecards and reports being made out as in regular industrial work. The product of the shop is also of a commercial nature, such as can be used for the cheaper grades of optical instruments, and it is expected in this way to make the training shop practically self-supporting. The shop is divided into three departments, each having a foreman. The material passes through the shop and is handled and inspected in the same way as it would be in a regular factory. The training shop, therefore, develops skill in all the numerous processes involved in lens grinding, chief among which are the following ten: Pitch-blocking, rough-grinding, medium-grinding, fine-grinding, taking-off, polishing, centering, edge-grinding, cementing, and inspecting. The course, however, does not include instruction in optical science, such as the calculation of lenses, and no instruction is attempted in the theoretical side of refraction. The foremen are competent to act as instructors, and are furnished by the large optical factories in Rochester, but are employed by the Government to take charge of the instruction.

Fig. 2. Lens Grinding Machines operated by Women in the Rochester Training Factory

Principles of Lens Grinding

The work of lens grinding is of considerable interest from a mechanical point of view, but differs, of course, largely from the methods used in grinding metal objects. The glass for the lenses comes to the factory in the form of sheets which may be either in strips 18 inches long and a few inches wide, or in squares up to 18 inches. The thickness of the glass varies according to the kind of lenses to be cut. It may be from 1/4 inch or less up to 1 inch thick. The glass is known as "optical glass," seven varieties being used. In the school strips are cut with a diamond to the approximate size of the lens required, and are then "nipped"; that is, pieces of glass are broken off at the edges until the approximate size is obtained. Very large lenses are made individually to the shape required before they are received at the factory. Before being cut apart or nipped, the glass plates are inspected for defects. In mass production, as in the large optical factories, the cutting apart or nipping process is not employed, but the glass sheets are heated to a white heat and the lenses are molded to a rough shape by dies in presses. Lenses so pressed are afterward annealed.

The blocking process now follows. This process consists in securing the rough lenses in a holder, in which they are held while being ground. The holder consists of a cast-iron block which is heated and then dipped in a pitch known as "bottle wax." The rough lens is then laid into this pitch while hot and soft, and when the pitch cools off, it stiffens and holds the lens firmly for the grinding operation. One or more lenses may be held on the same block. Instead of bottle wax, asphalt pitch is sometimes used. The objection to asphalt is that it melts at a comparatively low temperature, and hence may become soft and fail to hold the lens firmly.

Rough-grinding

The rough-grinding process in the training factory is performed by hand in machines of the type illustrated in Fig. 2. The general construction of the most important part of this machine is also shown in Fig. 1. A vertical spindle passing through the table is provided with a driving pulley at its lower end, while on its upper tapered end the cast-iron block holding the lens is mounted. This cast-iron block is known as a "shape." The shape is curved according to the curvature of the lenses to be ground. On top of the shape is loosely placed an upper part also curved to fit the shape of the lenses to be ground, known as a "shell." If the shape is concave the shell will be convex so as to fit it properly. Now, water and emery is placed between the lenses and the shell, the latter also being made of cast iron, and as the shaft of the machine and with it the shape and lenses are being rotated by the belt on the shaft pulley, the lenses are being ground to shape. The shell has a small center in its upper side into which enters a pin, passing through the handle as shown in Fig. 1. By moving the handle from right to left and vice versa, the shell is made to follow this motion through the action of the pin in the center and the lens is ground all over.

Fine-grinding and Polishing

For the rough-grinding, 90-grade emery is first used and later 150-grade emery. The rough-grinding ordinarily takes from fifteen to twenty minutes, after which the lenses are inspected and passed to the fine-grinders in which they are ground by using, first, washed emery and, finally, what is known as "white emery." After again having been inspected, the lenses pass to the polishing machines where 69PP rouge is used for the polishing operation. The surface against which the lens is polished is either a wax or a felt surface. The fine-grinding takes about fifteen minutes, while the polishing is a slow process which may require from an hour to a day or two, according to the character of the lens.

The rough- and fine-grinding is done either entirely by hand, one operator running but one spindle, or it may be performed in machines where one operator runs from five to six spindles. Polishing, in the training school, is performed by hand—one operator to one spindle—but in the regular factory it is always done by machines with mechanically operated handles; thus one operator may run as many as thirty spindles. In the training factory, however, it is con-

sidered best to perform all these operations by hand; however, one machine having five spindles is provided so as to give the operators an idea of how the mechanically operated polishers work.

Inspection after Polishing

While the lenses are inspected after all operations, the most thorough inspection is made after polishing. At this time the lenses are taken off from the shapes; this is done by placing the shape in an icebox which has the effect of loosening the pitch from the glass so that the lens can be knocked off without any of the pitch sticking to it. While the lenses are tested during the grinding operations by thin sheet-metal templets, which indicate that they have acquired roughly the shape necessary, they are tested after the polishing by test pieces, convex test pieces being used for convex lenses and vice versa, and the "light rings" (Newton rings) produced at the surface where the test piece and the lens coincide, are noted, as these indicate the truth of the lens.

Before the final inspection can be made, the lenses must be cleaned by dipping them in a wash in a tank. They are placed in trays and moved up and down in the wash by a machine, which removes any rouge and pitch that may adhere to them. The inspection in addition to determining the accuracy of the lenses, also calls for the detection of scratches, flaws, or other defects in the glass.

Centering

The lens is now correct as far as the shape on its surface is concerned, but the edge of the lens is rough, and it is not certain that its optical center is in the center of the rough circumference. It therefore becomes necessary to determine exactly where the optical center of the lens is located, and then to turn or true up the edge of the lens so that its optical center coincides with the geometrical center. The processes whereby this is accomplished are known as "centering" and "edge-grinding." In the centering operation the lens is held in a bench lathe on the face of a chuck by means of sealing wax. The wax at first is kept pliable by the application of a gas flame, so that it is possible to move the lens slightly on the face of the chuck. By the application of a tool similar to a female center in the tailstock of the lathe, it is possible to gradually move the lens in the pliable wax body until it is approximately true. To test the truth of the centering of the lens, that is, to determine that the actual optical center of the lens is exactly in the center of rotation of the chuck, the machine is revolved, the lens, of course, revolving with it. If it has been properly centered, the objects reflected in the center of the lens when visually inspected, will remain stationary to the eye, although the machine is running. The truing operation must be continued in the manner described in the foregoing until this condition has been fulfilled.

When the lens has been truly centered, a sponge holding cold water is used to cool off the chuck and stiffen the wax, in order to hold the lens firmly in place. Then the chuck and the lens are transferred from the lathe to an edge-grinding machine where the lens is ground on the edges to the right diameter and true with its optical center. The bench lathes are also sometimes provided with a grinding attachment whereby the edge-grinding can be performed directly in the lathe where the centering is done. After the edge-grinding is completed, the lens is removed from the chuck by heating the wax. The wax is cleaned off the lens in an alkaline solution, and the lens submitted to the final inspection. Sometimes several lenses are cemented together to produce certain optical results, in which case the cementing with an absolutely transparent cement is the last and final operation, except for still another inspection.

All the machinery in this training factory was built at the Rochester Athenaeum and Mechanics Institute, which speaks highly for the practical character of the work performed there. It was built by soldiers of the United States Army that are being trained in mechanical work at the institute, one of the training shops with the soldiers at work being illustrated in Fig 3.

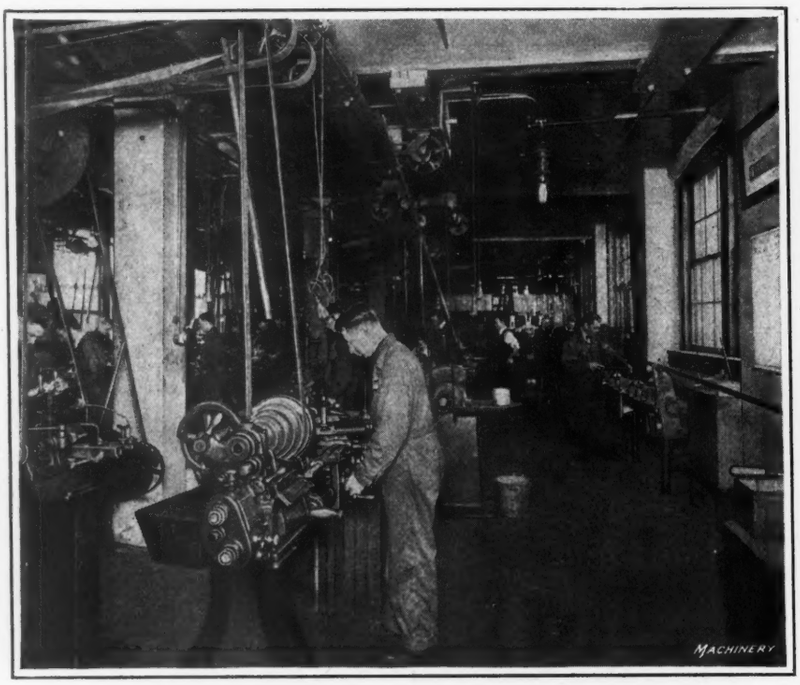


Fig. 3. The Lens Grinding Machines being made by Soldiers of the United States Army who are trained as Machine Operators at the Rochester Mechanics Institute

The training factory at the Rochester Institute is in charge of C. G. Hull, through whom the information contained in this article was obtained. Acknowledgment is also due James F. Barker, president of the Rochester Athenaeum and Mechanics Institute, for his courtesy and aid in securing the information on which this article is based.

* * *

During the past ten years, through adoption of more correct boiler and cylinder proportions, by the application of fuel-saving and capacity-increasing devices, and by the refinements in detail design, the American locomotive has been brought to a high degree of efficiency in operation and maintenance; but there has been no change, generally speaking, says the *Railway Age*, in regard to the weights of the reciprocating and revolving parts per unit of load. However, it has recently been possible by reducing the weight of the reciprocating parts on the Pennsylvania Class E6 engines to place 66,500 pounds on a single pair of drivers; yet these engines produce less strain on the track and bridges than many engines that have from 10,000 to 12,000 pounds less weight on the drivers. This reduction of weight of the reciprocating parts is made possible by the use of alloy steel forgings and castings, the use of hollow crankpins and piston-rods, rolled steel or alloy cast steel pistons, and by special care in the design of all details. Also, a special vanadium steel has been developed, known as "carbon-vanadium steel" that without heat-treatment other than simple annealing, has all the physical properties of heat-treated plain carbon steel.

* * *

Copper ranks next to steel as the most important war metal. Of the world's production of about 3,100,000,000 pounds in 1917, the United States produced 2,362,000,000 pounds.

INSUFFICIENT HELP AND EMPLOYERS' LIABILITY

BY CHESLA C. SHERLOCK

There can be no doubt but that practically as many workmen are injured or killed each year through the thoughtlessness and carelessness of fellow-workmen as through the negligence of their employers. However, accidents and injuries are not altogether dependent on the master's negligence or the carelessness of fellow-servants; they happen many times because the master has not employed sufficient help to carry on his work. It may appear to be straining a point to say that a person must employ a certain amount of help or be liable for failure to do so, but there can be no question as to the fact that many injuries are caused entirely by such failure. The courts in several states have ruled that it is the duty of the employer to furnish a safe place in which workmen may do their appointed tasks, to provide reasonably safe tools and appliances, and to employ sufficient workmen for the task. Indeed, this seems to have been the case also at common law. If a workman can show that his injuries were due to the fact that his employer did not have sufficient men, there can be no doubt as to the employer's liability in an action for damages, and it appears that, regardless of how the workman received his injury, if it can be shown that he would not have been injured had a sufficient number of workmen been employed, the employer will be liable.

Recent Court Decisions

In a Virginia case, a man was engaged in painting a railroad bridge. The foreman, standing about fifteen feet behind him, ordered the position of the scaffolding to be changed, using only three men for this work when at least four men were necessary. The painter had no knowledge or notice that the scaffolding was being moved, and, in fact, knew nothing until he was struck in the back and thrown to the rocks below. The court held that the evidence tended to show that the accident was the result of the foreman's attempt to move the ladders forward with three men when four was the smallest number that could move them with safety; that the foreman was standing where he could have seen the painter, by the exercise of ordinary care, and could have warned him of his danger, or could have stopped the men from attempting to move the scaffolding until he was in a place of safety; and that the foreman was under the influence of liquor, which alone was sufficient to account for the negligence of which the verdict convicted him.

In a Texas case, the plaintiff received injuries while helping another workman lift a heavy steel pin in the employer's factory. It was shown that the two men were ordered by the foreman to lift the pin from a truck, which was at once taken away; that the plaintiff had never lifted such a pin before and did not know its weight; and that it was impossible for the men to put down the pin or for the plaintiff to drop it without injuring himself and his assistant. The Court said: "It was the duty of the employer to ascertain and know whether it was safe for the employe to do things that he was ordered to do by his master and the employe should not be responsible for the ignorance of the master. If the appellant was ignorant of the weight of a pin and of the fact that two men could not carry it, he, and not the appellee, should be made to suffer for that ignorance. It was not necessary for the appellee to prove that the appellant had actual knowledge of the weight of the pin, but merely to introduce facts that made it the duty of the appellant to know such weight."

In an Oklahoma case, the employer was held liable in damages because of the failure to furnish sufficient help to the foreman of a gang constructing a storm sewer for a factory. It was shown that two men were necessary in the trench, which was seven feet deep, to cement the pipes together, and that two men were necessary on the ground to hand down the pipes by means of ropes. The evidence disclosed that the plaintiff had asked both the employer and the superintendent for additional help, but that they had refused to supply it and had ordered him to go on with the work as best he could. This lack of help made it necessary for him to reach to the surface for a pipe, which was handed to him by a helper. While reaching for the pipe, his fingers were badly smashed. The court held that it is the duty of an employer to furnish his employes with a sufficient number of competent fellow-servants to do the work properly, and if this is not done and an injury results to an employe by reason of this negligence of the employer, he is liable to the injured employe.

Limitations of Liability

In a New York case, the plaintiff was cutting lumber on a machine from which the employer had removed a device that prevented employes cutting themselves, claiming that it interfered with the amount of work which the plaintiff could turn out. The plaintiff made no objection to this and continued to operate the machine. He was, at that time, engaged in cutting boards about four or five feet long, which he could easily handle without help. A short time before the accident, however, he was given boards twelve feet in length to cut. He called the attention of his foreman to the fact that he could not handle these boards without help and was directed to continue the work and promised that he would get help. The plaintiff continued to work until one of the boards, because of its length, turned over and drew his hand into the knives, severely injuring it. There was no evidence to show just how long after the promise of additional help was made the accident occurred, but it was shown to be less than an hour. There was no evidence as to whether the foreman had had sufficient time to summon another workman or employ another one, but the court said that no liability in this respect could attach to the employer until after the lapse of a reasonable length of time. For this, and similar reasons, the court granted a new trial and reversed the judgment in favor of the employe. The court seemed to think that if there was negligence in the failure to provide an assistant, it was that of a fellow-servant with regard to a detail of work, for the reason that as long as it was only while operating with twelve-foot boards that there appeared to be any danger present, it was something for which the foreman was solely responsible.

Doctrine of Assumption of Risk

The Texas court has held that if a workman is employed in a factory or shop where there are insufficient workmen and he knows that the number is insufficient, but continues to work, that he will be held to have assumed the risk of such insufficiency of help. In states without workmen's compensation acts, the doctrine of assumption of risk is still in force, and if a workman is employed in a factory or shop which is not safe or is furnished with tools that are not safe, and he knows it but continues to work, he cannot recover damages from his employer because the courts will hold that he assumed the risk by continuing to work. In those states where there has been any legislation upon the subject of master and servant and common law defenses, particularly where compensation laws have been enacted, this defense of assumption of risk is abolished, not only to those employers operating under the terms of the statute, but to those who have rejected as well.

A Sufficient Number of Workmen

Naturally, the theory that an employer is liable in damages to an injured employe for failure to employ a sufficient number of fellow-workmen makes the term sufficient number of workmen of great importance. In courts of law, there are, in reality, two judges—the courts sitting in judgment upon the law in the case and the jury in judgment of the facts. Sometimes, the question of what is law and what is fact is worse than a Chinese puzzle to solve, but, it is safe to say, when in doubt that the question is for the jury. When a question depends largely on the facts immediately surround-

ing each case, the determination of what constitutes a sufficient number of employes is for the jury to determine. It may be a question of law in some cases, due to peculiarities not found in the average case, but where a dispute has arisen the courts have held it to be a question for the jury.

It is a noticeable fact that practically all of the cases reported upon this point disclose the fact that the injury to the employe was received while machinery, appliances, or tools were being moved from one part of the factory or shop to another, and without sufficient help. In rush periods when employers are anxious to keep production up to the highest point, and these odd jobs are necessary in the factory or shop, it is natural to fall into the habit of trying to get things done with one or two men when four or five are necessary.

Employers should guard against this. It is at the rush periods that accidents are most likely to occur. While there is a labor shortage, sufficient time should be taken to each task that might result in disaster, as the conservation of our present labor supply is more important than keeping production at a maximum all the time.

* * *

AN UNUSUALLY LARGE FORM CUTTER

The accompanying illustrations show a very large form cutter made by the Cleveland Milling Machine Co., Cleveland, Ohio, for the Watervliet Arsenal. It is to be used for milling hinge lugs for 240-millimeter howitzer jackets. The com-

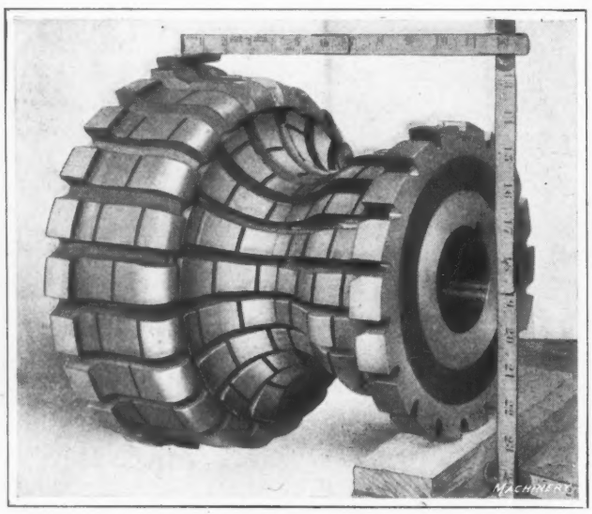


Fig. 1. Large Sectional Form Cutter, 12 Inches in Diameter and 12 Inches Long, used for milling Hinge Lugs for 240-millimeter Howitzer Jackets

pleted cutter measures 12 inches in diameter at the largest point and 12 inches in length. It is made in three interlocking sections, as shown in Fig. 2, and is driven on a three-inch arbor. There are twenty-two teeth in the largest diameter section and eighteen teeth in each of the other two sections. The relieving of the teeth was done on a Cleveland Milling Machine Co.'s standard relieving machine. In its finished state, the cutter weighs 200 pounds, and it is believed to be the largest form cutter ever made. C. L. L.

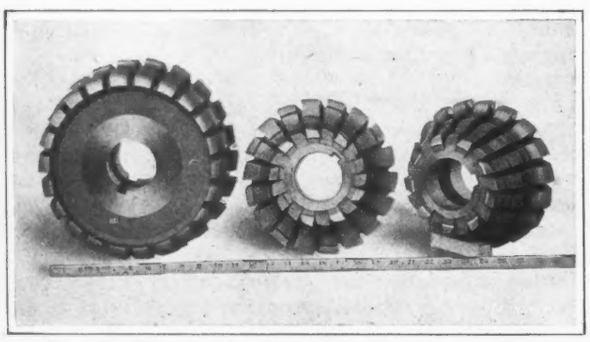
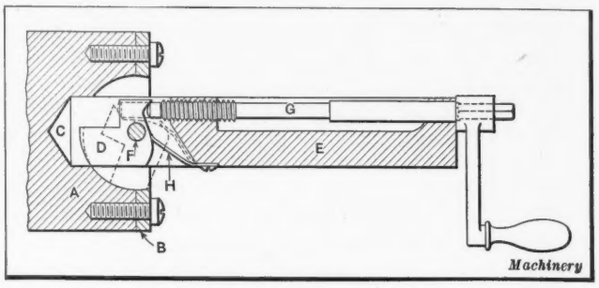


Fig. 2. Large Form Cutter taken apart to show Interlocking Sections

TOOL FOR BORING A HEMISPHERICAL RECESS

A satisfactory tool for turning a hemispherical recess for the ball joint on a press ram is shown in the accompanying illustration. This device was designed to machine the complete joint accurately by boring out the cast-iron ram *A*



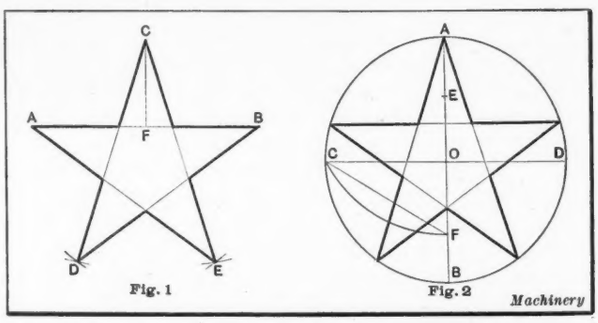
Tool for boring a Hemispherical Recess

and cover *B* in one operation. The cover *B* then forms a part of the hemispherical portion of the ball joint and prevents the ball from slipping out. Hole *C* is drilled to act as a guide for the boring device while in operation. The tool is clamped in the toolpost at a point near the handle. The device consists of the hardened steel tool *D* located in the slotted part of the boring-bar *E* and swiveled on pin *F*. In operation, the cutter *D* is brought into a horizontal position by means of the feed-screw *G* and the device is inserted in the previously drilled hole. To withdraw the tool, the feed-screw *G* is turned back until the spring *H* pushes the cutter back into its horizontal position. A. J. C.

* * *

DRAWING A FIVE-POINTED STAR

Although not exactly a matter of machine shop mathematics, the method of drawing five-pointed stars is of interest to machinists at this time, because they are often asked to make patterns for this star to be used in service flags. One man tried to make a pattern by turning up a disk and mounting it on the dividing head of a milling machine, planning



Figs. 1 and 2. Two Methods of drawing a Five-pointed Star

to index it around, but an appeal to one of his shopmates brought him two simpler and quicker methods. The first is of the rough-and-ready class and the second is theoretically accurate.

Draw a line *AB*, as in Fig. 1, and at its center *F* erect a perpendicular *CF* three-eighths the length of *AB*. To be strictly accurate, the distance *CF* should be 0.3632+ × *AB*. From *A*, *B*, and *C* as centers, with a radius equal to *AB*, strike arcs as shown, and from their intersections at *D* and *E* draw a line to points *A*, *B*, and *C*. The star is then complete.

By the second method, draw a circle, as shown in Fig. 2, with two diameters at right angles as *AB* and *CD*. Bisect the radius *AO* at *E* and, with *E* as a center and the radius *EC*, strike an arc cutting radius *OB* at *F*. The distance from *C* to *F* is equal to a side of the regular pentagon to be inscribed in the circle. By stepping around the circumference with the dividers set to the distance *CF*, the five points for the star can be located and the star drawn, as shown. G. H. G.

Types of Reamers and Their Use

BY LIEUTENANT-COLONEL E. C. PECK

Engineering Bureau, Ordnance Department, Washington, D. C.

VARYING degrees of accuracy result from the use of different tools employed in the drilling, boring, and reaming of holes. The cost of obtaining the accuracy required by some kinds of work would be prohibitive for others. Therefore, the proper tools for producing holes in any class of work, are those best adapted to produce the required accuracy from the standpoint of an over-all economy. By an over-all economy, is meant the greatest number of suitably finished holes that can be produced for each dollar paid out for tools, labor, and machine expense.

Drilled holes are neither round, straight, nor of uniform diameter when compared with the accurate holes required by most industries, although they may be sufficiently accurate to meet the requirements of holes for rough bolts, rivets, and similar classes of work. When a close fit is required, holes are usually finished by reaming. When holes of extreme accuracy are required, it is necessary to use two reamers in order to obtain the desired results. For all such work as holes for pins, rods, or finished bolts, one reaming operation is sufficient, and even in many cheap grades of machines the holes for journals are finished with a single reaming operation; but this is not the best practice. Before selecting a type of reamer for any class of work, it is advisable to study the cutting action of different reamers in order to select the one best adapted to each class of work.

Clearance of Reamer Cutting Edges

A reamer without clearance cannot cut, because its cutting edges cannot get under the surface of the metal to lift, or sever, the chip from the metal. If forced into a hole it merely rubs or burnishes the surface of the hole and either heats the tool sufficiently to draw the temper, or tears the hole, or does both. A reamer having proper clearance cuts freely and smoothly. There are three kinds of clearance, which may be described in the following order:

1. Longitudinal, which nearly all reamers should have to some extent. This is a slight taper which makes the reamer smaller toward the shank in order to prevent the back end from enlarging the hole or dragging and thereby roughing up the hole.

2. The clearance on the entering end of the teeth which every reamer ought to have.

3. The clearance along the sides of the teeth or on the peripheral part of the reamer. The latter is sometimes called radial clearance or relief.

As previously mentioned, end clearance on the entering teeth is absolutely necessary to the satisfactory entrance of the teeth to the cut, and it is obvious that there need be no further discussion on this kind of clearance. The only question to settle as regards the end clearance is how much it should be, and this will be discussed later.

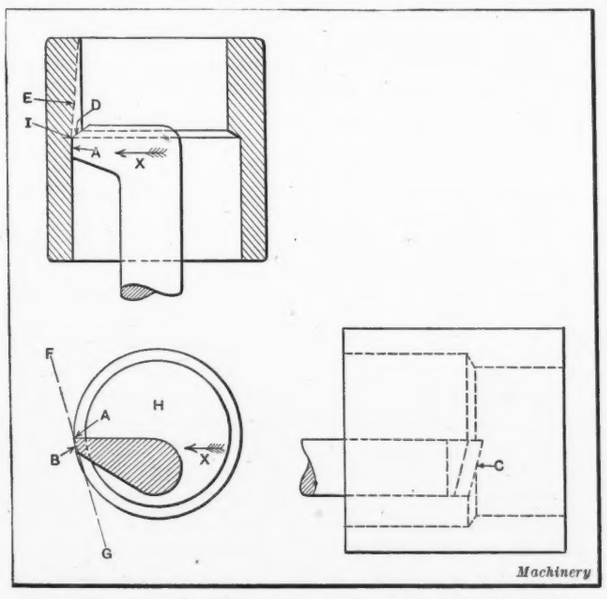


Fig. 1. Showing Action of Boring Tool not provided with Radial Relief

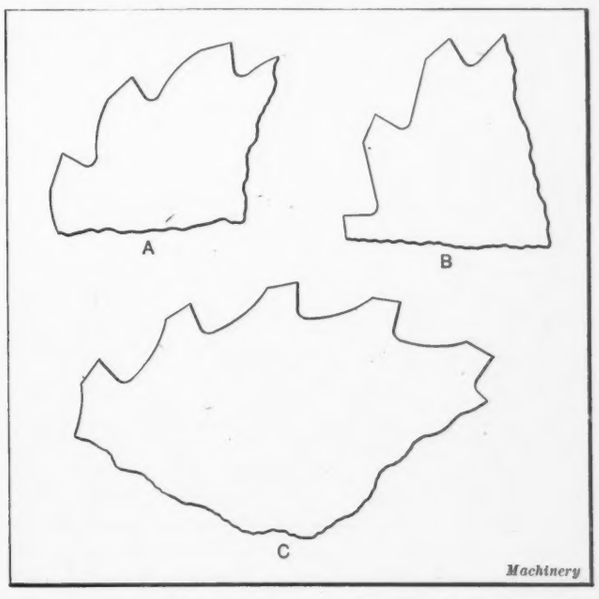


Fig. 2. Different Forms of Flutes used for Various Types of Reamers

Side Clearance or Radial Relief

The side clearance or radial relief is not so easily disposed of, and workmen's ideas on this vary somewhat. The action of a reamer without side clearance is best understood by comparing a single tooth of the reamer with a boring tool having no clearance behind the cutting edge as shown in Fig. 1, in which *H* is the hole to be bored, *A* the cutting edge, with small sector *B* exactly concentric with the hole. Clearance is shown on the end of the boring tool at *C*. It will be seen that great pressure would have to be exerted in the direction indicated by arrow *X* to hold the tool against the work, because the tool can only cut the metal at edge *D*, which enters the metal in the direction of the length of the hole, and therefore there is no cutting action accomplished by the part shown at *B*. This part only rubs, and as there is some spring to the tool it does not cleanly sever the chip produced by cutting edge *D*. Therefore, part *B* is forced outward at each succeeding revolution as the tool is advanced, which results in producing a tapering hole as shown by dotted line *E*. This could be overcome only by exerting enough pressure in the direction of arrow *X* to hold sector *B* absolutely to its line of travel and by having the surface so hard and smooth that it could not tear the wall of the hole.

Another factor that also tends to produce a tapered hole and that requires additional pressure in the direction of the arrow is the dulling or rounding over of the extreme corner of the tool at *l*. This dulling action is very severe at this point. The easiest and surest way to overcome these difficulties is to relieve the surface *B* along a line represented by *FG*. This reduces the required pressure in the direction shown by arrow *X*, and also lessens the trouble due to the dulling of the extreme cutting corner, and makes it possible to bore a hole, the sides of which are practically parallel. The hole will also be smoother, as the side of the tool will scrape out the roughness left by the dulled corner as it follows after it. It must, therefore, be evident that a reamer without radial or side clearance is working under great difficulties and the chances for accurate work are small. It is also evident that as the surfaces of the reamer, which correspond to *B*, advance into the metal they should be lubricated, but this could only be done by lubricating the cutting edges as well, which in some kinds of metal is an objectionable practice.

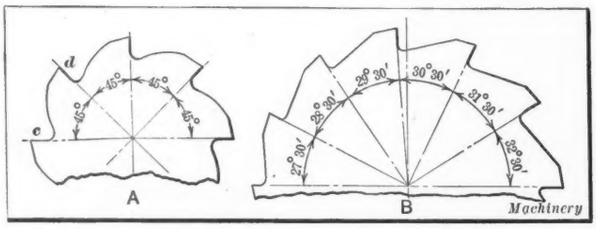


Fig. 3. Method of spacing Reamer Teeth

Form of Flutes

Next to clearance, the style of flute is of the greatest importance, as its shape and area determine the relative strength of the tooth and the ability to carry away the chips. Large chip space and strength are desirable features in all reamers, but they are of greater importance in reamers designed for taper-reaming and for use in machines. The cutting face of a reamer tooth should have a fillet beginning about midway between the top and the bottom of the tooth where great strength is desired and nearer the bottom where the strength is of less importance. This fillet does not reduce the chip area materially because the chips tend to curl in most metals and this curl conforms to the shape of the fillet. The shape of the back of the tooth should be a parabola, from the cutting edge to the base or junction of the fillet, to obtain maximum strength; but for manufacturing reasons, a straight line or reverse curve which is tangent with the fillet and which lies outside the parabola is standard practice. At *A* in Fig. 2 is shown the tooth with parabolic flank, which is rarely used except on heavy chucking reamers where the cuts are heavy; at *B* is shown the straight flank; while at *C* is shown the reverse curve flank largely used by most manufacturers. Shape *C* provides a large chip area and where uneven spacing is practiced the lands are more easily kept of uniform width.

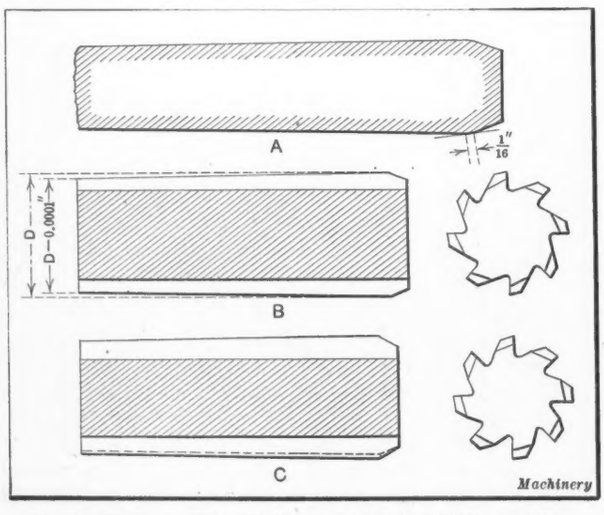


Fig. 4. Diagram showing Back Taper of Cutting Edges of Reamer

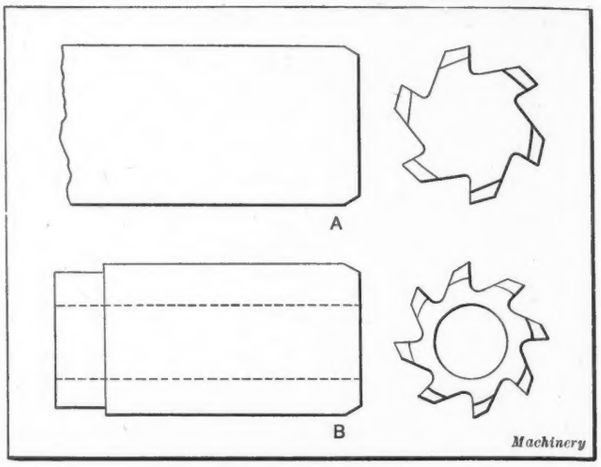


Fig. 5. Core and Shell Reamers

Methods of Preventing Reamers from Chattering

Another desirable feature in a reamer, and especially a taper or hand reamer, is that it cuts a round, smooth hole without chattering. There is an erroneous opinion prevalent that an even number of flutes chatter more than an odd number. This is a fallacy and our experience shows that an odd number of flutes will chatter as readily as an even number, especially when the reamer has more than four flutes. We venture the statement that no reamer will chatter if the amount of clearance is very small, but for some kinds of material this slight amount of clearance would require too much effort to force it to "take hold," and this extra force might cause it to bite in sufficiently to break out a tooth. To make reamers suitable for reaming most kinds of material met with in ordinary practice, a considerable amount of clearance must be given and this would produce chatter by biting in unless it is offset by some other features.

At *A*, Fig. 3, is shown an evenly spaced reamer. First let us assume that it has standard clearance, that it is just at the point of biting in, and that the reamer jumps as turning pressure is exerted. As soon as the chip is broken by the jump, the reamer starts to cut normally until it reaches a position in the rotation at which the tooth *c* occupies the space formerly occupied by the tooth *d*. Every other tooth will have simultaneously reached the exact position occupied

by its predecessor, or the point at which the biting in occurred; consequently, the reamer will jump again. This will be repeated every time a tooth reaches the mark produced by biting in, and each successive jump will increase the defect in the hole and thus prevent making it smooth. Obviously, this can be overcome by making the reamer so that a considerable part of a rotation can be made before the cutting edges will again coincide with the marks of the bite first made. This enables the teeth to remove these marks by cutting over them progressively, and the reamer thus steadying itself in the hole proceeds to cut smoothly. One method of spacing is shown in Fig. 3 at *B*, and it will be seen that the exact position in which the cutting edges coincide can occur only at each half rotation of the reamer, an amount which our experience has shown to be amply sufficient.

Chamfer of Chucking Reamers

The entering cutting edges on chucking reamers are usually beveled at an angle of from 40 to 50 degrees for the purpose of keeping the extreme cutting corner as obtuse as possible which helps to keep it sharp for a longer time. This cone shape also aids the reamer in centering itself in the work. Hand reamers have a much longer taper, about 0.015 inch per inch, and they are used for finishing purposes only. These reamers are but slightly smaller at the entering end, as it is necessary to remove only a small amount of metal in the finished process. This long taper allows a scraping cut to be taken in such a manner that very accurate and smooth holes are produced. Fluted chucking reamers which are sometimes required for very accurate and smooth holes often have a slight second bevel in addition to that already mentioned, which acts like the taper on a hand reamer, thus making a smoother hole than would otherwise be the case. This is shown in Fig. 4 at *A*; the length of this second taper need be only 1/16 inch.

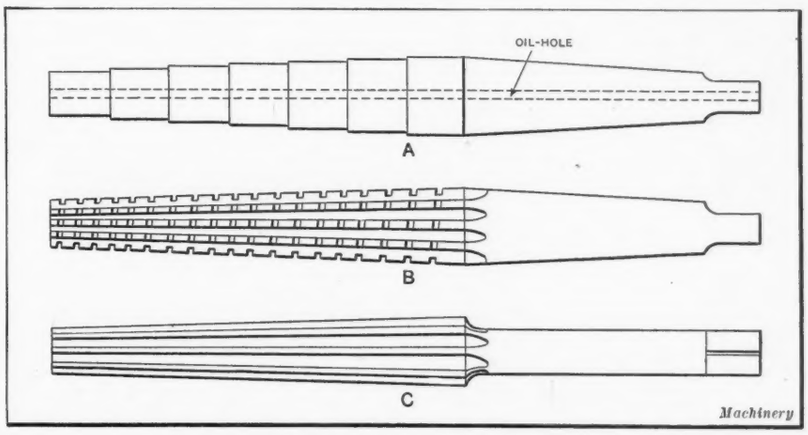


Fig. 6. Roughing and Finishing Reamers for Tapered Holes

Back Taper for Cutting Edges—Chucking and Core Reamers

While the cutting edges of both hand and chucking reamers should, theoretically, conform as nearly to a perfect cylinder as it is possible to make them, it is extremely difficult to grind reamers perfectly parallel from end to end of the flutes and they are usually made 0.0001 to 0.00025 inch smaller at the shank end of the flutes; this slight taper prevents the enlarging or scratching of the hole. It is obvious that if this extreme accuracy in sizing a reamer is required for good work, it is impossible and a waste of time to attempt to hand-stone a reamer to size. It is better not to use whet stones on a reamer, except to remove a burr or a piece of metal which has adhered to it.

At *B*, Fig. 4, is shown a reamer which is made with clearance on the beveled ends of the teeth; it is ground smaller toward the back end of the flutes, and there is no radial clearance. The action of the sides of the flutes has been fully described in a preceding paragraph. This reamer has a more limited use and is not as well adapted to reaming soft metals as those having radial clearance. In machinery steel or soft tool steel, however, it will perform fairly satisfactory work with light cuts and a flood of good lubricant. The reamer shown at *C* is a fluted chucking reamer, which is one of the most successful of all machine reamers, being widely used for all kinds of metal. It has all three kinds of clearance which have been previously described, but has much less longitudinal clearance than the reamer shown at *B*.

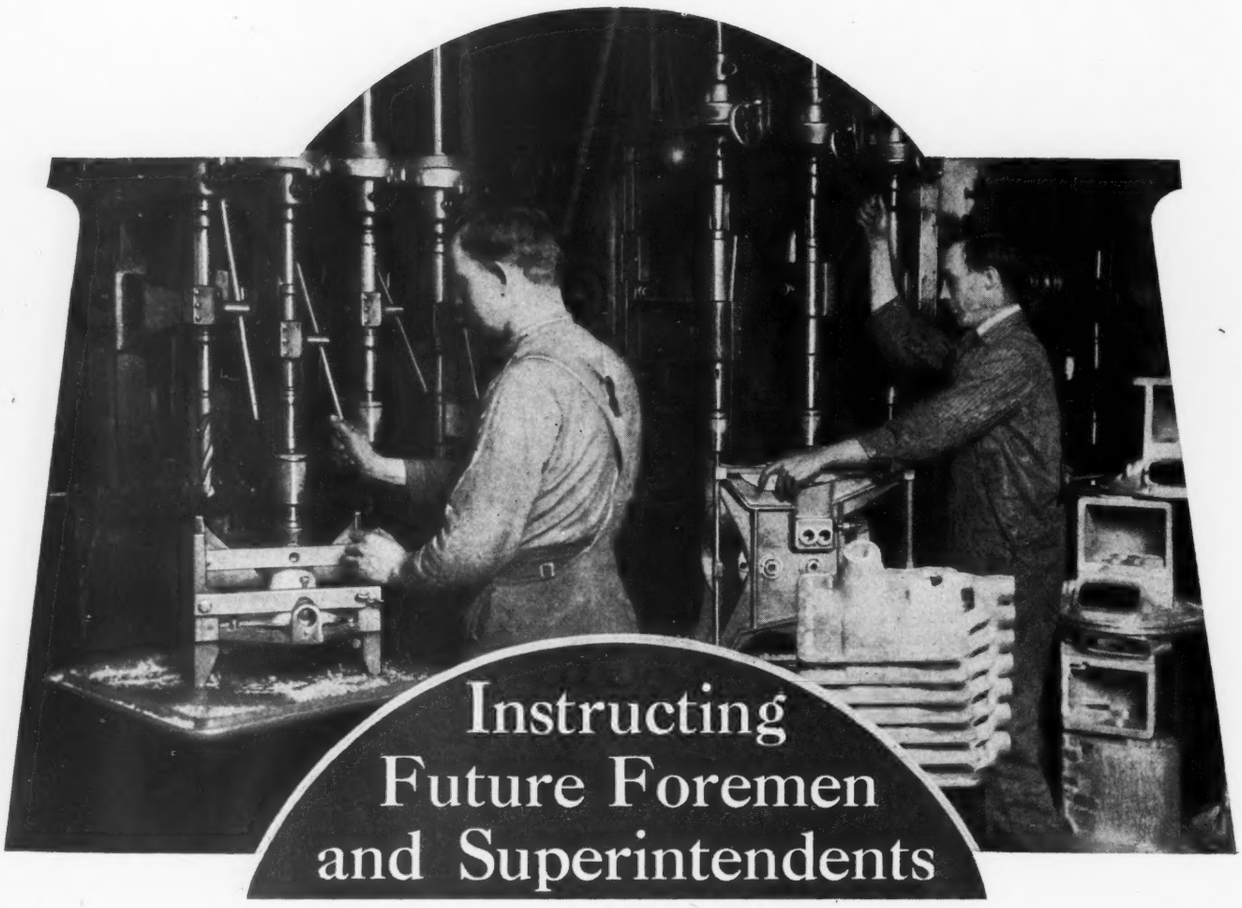
At *A*, Fig. 5, is shown a type sometimes called a "core reamer." This tool is intended for taking heavy cuts where only ordinary accuracy is required. It is made like the fluted chucking reamer except with stronger flutes and more chip space. The three types of reamers shown at *B* and *C*, Fig. 4, and at *A*, Fig. 5, are made with both straight and taper shanks; this is true also of the shell type illustrated at *B*, Fig. 5. No economy will be found in the use of shell reamers below 1 inch in diameter, as considerable trouble arises from a lack of fit of the arbors in small reamers of this type caused by dirt, burrs, etc., which may easily throw the reamer body out of line, and many small reamers are split by driving the arbor into a shell reamer which has a chip in the back end of the hole.

Roughing and Finishing Reamers for Tapered Holes

Fig. 6 illustrates a step, a roughing, and a finishing reamer for reaming tapered holes. The step reamer *A* is designed for use in a machine and is usually provided with a longitudinal hole through which lubricant can be forced. The roughing reamer *B* is provided with a left-hand spiral groove for the purpose of breaking up the chips. This groove also prevents the reamer from pulling in. For collets, spindles, etc., which have a taper hole, these reamers will be found to give excellent results, and they are capable of doing this work very rapidly. When the reamers *B* and *C* are used in a machine, they are also provided with oil-holes. Spiral-fluted reamers possess no advantages over straight-fluted ones except where there is a slot or opening in the hole that might cause a straight-fluted reamer to jump. Heavy fluted chucking reamers are sometimes given a right-hand spiral to give rake to the end cutting teeth. This also allows the reamer to be fed into the work more readily. If a spiral finishing reamer is required it should have a left-hand spiral for taking a right-hand cut in order to prevent screwing itself into the work.

Finish-reaming—Floating Reamers

A careful observance of the foregoing principles should enable one to analyze the conditions that exist in any class of work and to make the proper selection of reamers for the work. It should always be borne in mind that a reamer produces its best work when taking light cuts. For final accurate reaming, the hand reamer clamped in a vise by its square end will be found best; this allows the work to be screwed down over the reamer by hand. If the holes are being finish-reamed in a machine, the reamer should be held in a chuck, collet, or holder that will float smoothly without jumping. The best work is done with holders that allow the reamer to float perpendicular to its axis as well as at an angle. This floating action is necessary because it is nearly impossible to hold the reamer so that it is exactly central with the hole and at the same time have the line of travel of the axis of the reamer coincide or line up with the axis of the hole. All three points are necessary for accurate work, and the floating holder compensates for this lack of alignment.



Instructing Future Foremen and Superintendents

BY FRED H. KORFF

Assistant to Factory Manager, Wright-Martin Aircraft Corporation, Long Island City, N. Y.

AFTER taking a course some years ago in machine and tool design at a technical evening school, the writer became convinced that the evening trade schools in general give good courses. This opinion was formed not only from his experience but from visiting many of these schools and looking over a large number of catalogues describing the courses, methods of teaching, and equipment employed. However, in some cases the courses are not as complete as might be desired, and often the things taught are not applicable to everyday practice although they may be theoretically correct. In cases of this kind it would be of greater advantage to the student if he were shown the more practical methods which are used in actual shop work instead of devoting so much time to the study of theories. The following is a brief review of the methods employed at the evening trade school which the writer attended.

Preliminary Work at the Evening Trade School

Upon entering the school for the first night's instruction in machine and tool design, the student was placed at a drawing table and given the necessary paraphernalia for drawing. Naturally, it would be supposed that there would be a small amount of time spent in the preliminary work relative to the use of drawing instruments, which would be followed by instructions to draw some simple objects. Instead, a great deal of time was spent in preliminary work relative to the accurate drawing of lines, their shading, thickness, etc., which can be quickly acquired from actual experience if one simply understands the use of drawing instruments.

After two or three weeks of this class of work, the students were given small parts to draw, such as small wooden blocks of square and rectangular shapes. The course then proceeded along steps which gradually advanced from the drawing of the simplest parts to the more complicated ones, until the first period had been completed. The students were then advanced to a class in machine design where they were taught the design and drawing of various machine parts. As the students advanced through their course, they entered a period where the design of tools, jigs, dies, etc. was taken up. One of the first steps was the making of a simple drawing of the tool or jig and then the fully detailed working drawing. This procedure was perfectly proper, but when the detailing took place, great stress was laid upon the methods used to designate the threads of different bolts and studs. In these cases the students were required to show the threads accurately drawn to scale. Too much time was spent on unnecessary details which should have been devoted to the teaching of the principles which would enable the student to become a fast and accurate machine designer.

Machine Instructions in the Shop

The students, after completing the preliminary work, were placed in the shop, shown the different machines, and instructed in their operation. These instructions were oral, and related to the care, cleaning, oiling of bearings, feeds, stops, etc. Instructions were also given as to the methods employed in performing work on the different machines, and methods of holding the work so as to allow continuous cuts to be taken over the entire surface, emphasis being laid on the necessity of taking care in fastening the work so as not to distort the piece. These instructions, while good, were not followed by sufficient actual practice on the various machines. The writer will not attempt to touch on what might be done toward improving the theoretical side of the course, but he would like to suggest a shop course along the lines briefly described in the following paragraphs.

Machine Shop Course for Future Foremen and Superintendents

The periods of the first year should be divided into a certain number of hours covering the following stages: Shop mathematics, which should include arithmetic and element-

ary algebra. Drawing, one period being given to free-hand drawing, and the remaining equally divided between mechanical drawing and shop work. In this case the shop work should consist of instructions in joinery and patternmaking. In the second year shop mathematics, including the second book of algebra, and if possible, the first book pertaining to geometry should be taught, as well as the elementary solution or what is often called the "tool-room solution of right angle triangles." It would be advisable to devote periods to the study of industrial chemistry, mechanical drawing, and forging, the remainder of the time being spent in machine shop practice. The matter relating to machine shop practice will be more fully dealt with in a later paragraph.

In the third year physics and mechanical drawing should be taken up, the remainder of the periods being equally divided between machine shop practice, lectures, recitations and discussions relative to the heat-treatment of steel, and the study of the performance of various machine tool mechanisms in their relation to production problems. In the writer's opinion, there should be a fourth year divided into two terms. The first term of the fourth year should be divided into the following periods: Mathematics touching on geometry, lectures and elementary work pertaining to the strength of materials, and mechanical drawing, the remaining periods being divided between machine shop practice and a continuation of the lectures, recitations, and discussions held in the third year. The second period of the fourth year should cover an advanced course in physics pertaining to lectures on heat and sound, shop problems and mathematics, production problems, and efficiency methods. An advanced course should also be given in the design of tools, dies, and jigs in connection with the course pertaining to shop management, cost keeping systems, bonus plans, and payment of the workmen. If possible, visits to local concerns should be made in order to obtain first-hand knowledge of the management of modern factories. It is the writer's opinion that if the details of a course such as has been described were carefully carried out and adopted by the different trade schools, the demand for competent foremen and superintendents could be more easily met. This would eliminate the haphazard methods of choosing a trained foreman or superintendent which are in use at the present time.

Instructions for Operating Drilling Machines

The machine shop course should commence with oral instructions relative to the machines on which the students are to work, and prior to the time they are allowed to operate a machine, they should attend lectures at which the functions of each machine are described and the use of the different controlling levers fully explained. As the student enters the school, in many cases, without any previous mechanical experience, it would be advisable to allow him to first operate a drilling machine, which is one of the simplest machines in the factory. The students, as a class, should be given instructions on the use of drills, and the different kinds that are on the market should be described; also, the purpose for which each type is used should be carefully explained. Instructions should be given relative to the proper grinding angle, how the different angles are adapted to the drilling of different metals, and how speeds vary for the different kinds of metal and the size of drill that is used. Instructions should also be given on the care of the drilling machine, including oiling, cleaning, and adjusting.

One of the first lessons should be to locate holes of various sizes in a piece of work from the dimensions shown on a blueprint. Before attempting to drill a hole, the importance of grinding a drill properly should be firmly impressed on the student's mind, in order that the hole drilled may be perfectly round and in the proper location. When the student has learned how to drill one hole in a fixed location, he should receive instructions on how to lay out a plate with a dozen or more holes at fixed distances from each other, and then be permitted to perform the drilling operation. It would be well to explain to him that this practice of laying out holes at fixed distances is very valuable, as it is applied in laying out the bolt holes in a pipe flange, crankcase, or cylinder head used either on an automobile or an airplane motor. When the student has learned how to drill one or more holes at different distances, and also how to pull a drill which has been started off center back to the true center, he should be given instructions on the use of taps. First, he should be told just what a tap is, what it is for, how it is made, and how the taps vary according to the different size tap drills which are used. The difference between the U. S. standard, the Whitworth and S. A. E. taps should be fully explained, as well as the purpose for which each is designed.

When the student has received thorough oral instructions on these points, he should be permitted to tap out the holes which he has previously laid out and drilled. Great stress should be laid on the fact that a tap must always be kept perpendicular and at right-angles to the work which is being tapped, and instructions should be given explaining how to tell by the feel of a tap just how much it may be expected to stand in the way of pressure. When the student has tapped the holes, the next operation should be to drill blind holes in cast iron and steel. The student should then receive instructions on the use of a bottoming tap in a blind hole. The next step should be instructions covering the method of removing taps from cast iron, should they become broken, without the necessity of annealing in order to soften the tap so that it may be drilled and tapped out.

After the student has been instructed as to the methods of tapping holes by hand, he should be shown how to tap a hole by using the drilling machine and how the tap may be backed out by reversing the spindle. This is a lesson that must be carefully taught before the student is allowed to use a machine, as many taps may be broken if this is not fully understood. At this point the student should be instructed how to use portable electric drilling machines, using different sized drills on different metals, and how to lay out holes from different angles and on odd-shaped pieces. When several periods have been given to this, it might be well as a finishing lesson on the drilling machine to permit the student to drill and bore out a blind hole such as a cylinder block with a hole extending through the casting, or a cylinder-head casting, which would permit boring a blind hole. In this case counterbores and spot-facing tools should be brought into operation. The student would then have a good general knowledge of the principles governing the operations which may be performed on a drilling machine. After the student has received instructions relative to operating a drilling machine he should be ready to receive instructions on the operation of a lathe.

Instructions for Operating Lathes

Following the same procedure as for the drilling machine, the student should first receive full instructions relative to the operation of a lathe, and the necessity for care in cleaning, oiling, and changing the gears should then be explained. He should be taught that one of the paramount rules that must be observed by a lathe operator is to make sure that all work is set up properly prior to placing the lathe in operation. One of the first pieces of work should be the machining of a piece of mild machine steel to an accurate length and diameter. It might be advisable to give the student a lathe having a pair of centers which are not true. When he has finished the piece and attempted to measure it for concentricity, let him figure out why the piece does not come true, and if he is unable to determine the reason, explain to him how necessary it is that the centers be true if precise work is to be turned out. The student should then be shown how to grind the centers of a lathe in order to produce work which is absolutely concentric.

When this operation has been performed satisfactorily the next step is to turn a piece with a shoulder, which should be finished all over to accurate dimensions. The student

should learn to use a pair of calipers and a scale correctly, so that he can tell by the feel of the adjusting screw of the calipers how close the work is to the required dimensions. When this stud is finished and has been passed by the instructor, a stud should be turned with a shoulder at both ends, which would have the appearance of a miniature dumbbell, except that the shoulders would be square instead of round. He should be given a pair of micrometers and told to machine this stud all over within a limit of tolerance of not more than 0.002 inch.

After finishing the preceding operations, the student should be instructed in the method of setting over the tailstock on a lathe in order to turn a taper. Instructions should be given on the method of figuring the taper per foot, and how to determine the amount which would be necessary to move the tailstock off center in order to obtain the desired taper.

The student has now received instructions on straight and taper turning, and the next step is the cutting of threads. Before attempting to cut threads on a lathe, the student should be given lectures on threads in general, and a full description of the different kinds and standards in common use, as well as formulas for determining the diameters, angle and depth of thread, etc., of the different types.

He should be instructed in the use of change-gears so that he will understand how different gears are applied to a machine for cutting different numbers of threads per inch. When the student's instructions relative to thread cutting on the lathe have been completed, he should take a piece of steel approximately one inch in diameter and using the proper gears, attempt to cut a U. S. standard thread. The first attempt may possibly be unsuccessful, and he may require several pieces before he will be able to produce an accurate thread. However, experience is really the best teacher, and the student should not be hurried but advised to take his time in order to produce a finished and accurate thread. When he has thoroughly mastered the work of cutting threads by the standard methods, he should be permitted to cut multiple threads. After the cutting of a multiple thread has been explained, and he has succeeded in cutting a thread of this type, he should attempt to catch the thread by running the carriage back by hand without stopping the lathe. This is not easily done at first, and it may take him a little time to accomplish it, but it will be a lesson well learned. The next step is the cutting of internal threads, both in large and small holes, and when the student has mastered this step, he should be instructed in the cutting of a left-hand thread in a blind hole which is the most difficult of all threading operations.

The student has now become well versed in plain turning between centers, and has a good knowledge of thread cutting. Instructions should next be given relative to turning pieces between centers with the use of a steadyrest. Instructions should also be given relative to the use of chucks of different types and the use of testing devices in connection with all types of lathe work. The student should learn how to chuck castings and forgings of odd shapes and how to machine their surfaces accurately. He should also become familiar with the method of boring holes, both cored and blind, and learn to drill holes accurately from solid pieces.

It would be advisable to make arrangements with some large manufacturer whereby a large quantity of repair work could be turned over to the school. This would permit the student to obtain a great deal of experience in different varieties of work, which would assist him in learning more rapidly than if regular routine work were given him. If this class of work is impossible to obtain, it would be advisable to purchase some old gasoline engines and have the cylinders bored out and bushed to smaller sizes which would change the general contour of the interior of the motor and make it necessary to machine new pistons. The writer has found that in an instruction school an old gasoline engine can be changed in many ways, thereby giving the student first-hand knowledge of the various parts and how they should be machined.

As final instructions to the student relative to the operation of the lathe, it would be advisable to teach him the method of machining concentric and eccentric rings, such as piston rings, etc., and if possible, additional oral instructions relative to the proper lubrication and the various scientific details which enter into the proper functioning of a lathe should be given.

Instructions for Operating Milling Machines

When the student has become thoroughly familiar with the operation of a lathe, the next instructions should be in the use of a milling machine. The first instructions should be on the care and oiling of the machine, and great stress should be given to the fact that serious accidents can easily occur if the fingers are not kept away from the entering side of a revolving cutter, and that brushes and waste must not be used, when the machine is in operation, near the cutter where they might catch and pull the hand under the cutter.

The student should first attempt to mill a piece of work square, and when this lesson has been thoroughly mastered, he should advance to the point of doing complicated milling, such as cutting the keyways of a shaft with an end-mill, making taps, reamers, and drills. The use of dividing heads and the milling of punches and dies to a prick-punch layout should also be explained.

The student is now ready to take up the problem of milling gears and should receive full instructions relative to the use of the index chart which accompanies all dividing heads. He should be told how the figures are obtained which give the ratio of the number of revolutions of the worm in the dividing head to the number of revolutions which it is desired to obtain in the work. When he thoroughly understands this, he should be given a blank on which spur gear teeth are to be cut. From this operation he can advance to the cutting of bevel gears and the milling of helical teeth on reamers, cutters, etc.

When the student thoroughly understands the method of cutting different types of gears by using a single-tooth cutter, he should be instructed in the method of roughing out a blank with a single-tooth cutter, changing the arbor and finishing with a hobbing cutter. On receiving final instructions relative to the operation of a milling machine, the student should be required to mill a long flat piece of steel and then graduate it, thus making it into a scale. In this operation the student must thoroughly understand that in the laying out of all graduations the total sum should be taken from the first graduation and worked from that as a unit of one, and not from the first to the second and the second to the third, as in doing this the factor of error would increase with each graduation, whereas by working from the initial point, it would be minimized.

Instructions for Operating Planers

The student is now ready to receive instructions in the operation of a planer. The first work attempted should be the planing of flat surfaces, and he should be instructed in the use of clamps and straps, and shown how, when blocking work, care should be taken not to distort the piece; also, how it is important that the work be set up in such a way as to allow a continuous cut to be taken over the entire surface. The different types of tools used for taking roughing and finishing cuts should be studied.

The use of gages, templets, and different types of measuring instruments and their adaptability to various classes of work should be thoroughly explained. The student should be required to forge and finish special forming tools for machining irregular-shaped parts. He should be taught that the part to be machined should be so set up and clamped to the table that the least number of changes in set-up will be involved, as it is not the machining of the piece alone that counts in production, but the length of time required in making the different set-ups.

As in the case of the work which was done on the other machines, it would be advisable to obtain repair work, for

the planer is adapted to a large class of work and the student will obtain a far better working knowledge of the machine if each lesson varies in its character. When the student has mastered the main principles pertaining to the operation of a planer, he has reached the point where there are practically only two machines on which he requires further instructions—a horizontal boring mill and a universal grinder. If he succeeds in operating these, his education as a machinist will be complete.

Instructions for Operating Boring Mills

In the operation of a boring mill, it would be advisable to obtain an old gas engine, as was suggested in the case of the drilling machine and the lathe, for the student could then face the cylinder block for the exhaust manifold and oil and water pipe flanges. In connection with boring closed- and open-end cylinders, the boring of a block of four cylinders so that each hole will be a micrometric distance from center to center should be undertaken. The numerous boring jobs which come up from time to time in the construction of any mechanical apparatus should be observed, and the methods of performing any difficult operations noted.

Instructions for Operating Grinders

Before the student is permitted to operate a grinder, he should receive instructions relative to the selection of grinding wheels for different classes of work, the various cooling compounds which are used, the proper mounting and balancing of grinding wheels, the use of magnetic chucks, and the methods used to demagnetize the work after it has been ground. The different methods of holding work where a magnetic chuck cannot be employed should be taken up. For practical experience the student should be allowed to grind hardened steel parts such as mandrels, arbors, drill jig bushings, straight and taper grinding shanks for drills and reamers, milling cutters, spiral cutters and end-mills, dies, and punches of various shapes and sizes.

Such a course as outlined above would be of inestimable value in training a student in the requisites necessary to become a foreman or superintendent. This course has been described in detail. There are, however, a few items which might be eliminated, but as a whole, the writer is of the opinion that if such a course were instituted in the trade schools, the present difficulties experienced in obtaining skilled men for executive positions would be overcome.

* * *

EFFECT OF IMPURITIES IN ACETYLENE ON QUALITY AND COST OF WELDS[1]

BY CHARLES BINGHAM

The chief impurities found in or accompanying acetylene are sulphur, phosphorus, silicon, and finely subdivided lime, which affect the quality of the weld, and hydrogen, nitrogen, and their compounds, and water vapor, which affect the cost of the weld by lowering the temperature of the flame, thereby slowing down the welding process and thus increasing the charge for labor, carbide, oxygen, and overhead charges. Occasionally other impurities are also found, but their occurrence is so rare that they need not be considered.

Sulphur is found mainly in the form of sulphuretted hydrogen. Most of it is held in the sludge and in the water, but a part always finds its way into the gas and, unless removed, passes into the weld. Sulphur makes the steel or iron "short" or brittle. It is also one of the chief agents in the corrosion of metal pipes, faucets, etc. The quantity of sulphur compounds may vary from 0.1 to 2.4 per cent by volume; the quantity always increases with an increase of temperature in the generator. Nearly all the sulphuretted hydrogen can be removed by a good water-scrubber; the remainder is easily removed by a chemical purifier.

Phosphorus attacks the metal work of the apparatus and when burnt in the form of phosphoretted hydrogen it is the chief cause of the unpleasant atmosphere often found in welding shops. It makes the weld porous and any that is present in the gas passes almost entirely into the weld. The quantity of phosphorus compounds in acetylene can be as large as 1.2 per cent by volume. Phosphorus can be removed only by a good chemical purifier.

Silicon is usually found in the form of siliciuretted hydrogen. The gas may contain as much as 0.63 per cent by volume. Nearly all purifiers that remove phosphorus and sulphur fail to remove silicon compound, but as yet no experiments have shown that the presence of silicon has a bad effect on the weld.

The temperature of generation influences considerably the quantity of finely subdivided lime carried by the gas. This lime dust passes freely through the water, but the quantity present is usually small and can easily be removed by any good chemical purifier. The effects of the lime dust on welds has not been carefully studied, but the dust frequently chokes the narrow passages of the blow-pipe and some authorities claim that this causes spitting of the blow-pipe.

A yellow, brown, or black patch in the sludge is a sure sign that the temperature of the welding part of the flame, that is, the inner cone, is being lowered by hydrogen, water vapor, etc. Water vapor is a most pernicious diluent. It is decomposed at the high temperature of the oxy-acetylene blow-pipe, its decomposition requiring 2300 calories per cubic meter. At a temperature of 100 degrees F., the mere passing of the acetylene through the water will cause it to be saturated with about 5 per cent of water vapor. Where there is no water-scrubber and the generator is overtaxed, it is possible for a considerable percentage of the vapor to reach the blow-pipe nozzle before it has been able to cool down sufficiently for any condensation to take place. Even where a water-scrubber is used the acetylene will be saturated with water, and the higher the temperature of the water the higher will be the percentage of the water vapor.

Essential Factors in Oxy-acetylene Welding

Carbide expands to about twice its volume when decomposed; if there is not sufficient space for it to swell freely, overheating and partial decomposition of the acetylene follow. This is also accompanied by over-production of water vapor. To produce the best results, the generator should produce acetylene at as low a temperature as possible; the temperature of the gas and water in the holder should not exceed, say, 30 degrees F., the temperature of the air. The acetylene should pass through an efficient water-scrubber, but the water in the scrubber should not become too warm and should be frequently changed so that it will not become saturated with ammonia or sulphur compounds. The chemical purifier provided for removing phosphorus and sulphur compounds must, also, be regularly renewed or regenerated. The gas must be dried. An efficient method of doing this is to pass the gas after it has gone through the water-scrubber, through a vessel containing live carbide. The moisture in this case will produce additional acetylene but will be practically dry.

[1]Abstract of a paper read before the British Acetylene and Welding Association.

* * *

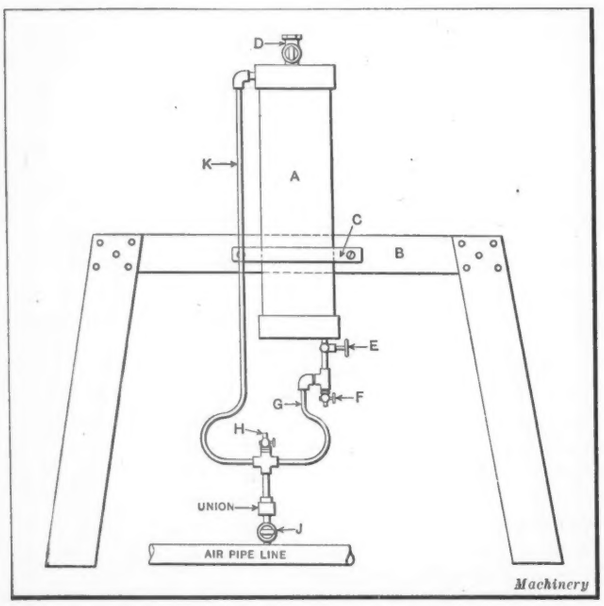
The New York subway extension system represents one of the world's greatest achievements in electric railway construction. According to the *Railway Review*, it consists of 619 miles of track, 200 miles of which are underground. This system serves five boroughs of the city and has a capacity for three billion passengers a year. New York, after five years of construction work and expenditure of $400,000,000, or more than the cost of the Panama Canal, has completed and put into operation the greater part of a new system of rapid transit known as the "dual system" because the Interborough Rapid Transit Co. and the Brooklyn Rapid Transit Co. have cooperated with the city in developing it. Third tracks have been added to the elevated railways on which express service is provided during the rush hours. To meet the increased power requirements, the Interborough Co. has installed an 80,000-horsepower Westinghouse turbine generator, which is the largest in the world.

ICE IN AIR PIPES

BY A. A. M.

Every plant using compressed air is troubled with ice forming in the pipes or machines during cold weather. On ship work, which is generally conducted out of doors, this trouble may cause a complete shutdown. Although various remedies have been applied by the different yards, there seems to be no generally accepted plan for eliminating this trouble. In considering a remedy, the cause should first be determined. Of course, if there were no water in the pipe, or if the temperature were maintained above freezing, there would be no ice, regardless of the water content.

One of the eastern yards found that during cold weather the air drawn from the low points on the line was more like a spray of water than a jet of air, and that in a few minutes ice formed in the hose or in the constricted passages of the lines or machines and cut off the pressure, with the result that considerable time was lost daily. As a remedy, a pipe coil that had been used for heating was connected to the line and a fire built on top of it. Although the air passing through this coil was raised to a high temperature, after it had passed through fifty feet of the hose it would freeze again. Owing to the lack of mechanical care in the application of the heat, a fire sufficient to maintain steam in a 10-horsepower boiler was not able to deliver warm air to the machine; besides, the air compressor was taking air from inside the engine room, where the worst possible conditions existed both as to the amount of water contained in the air and the economy of compression. Lowering the temperature of the intake air 50 degrees increased the amount of air delivered to the pipes about 10 per cent.



Apparatus for injecting Alcohol into Air Lines to prevent Freezing

In another yard, a small cast-iron manifold was made in which a steam jacket surrounded the air passage. While the air passing through this manifold was heated successfully, it cooled very rapidly after entering the air line. By placing a steam covering on the air hose, warm air was delivered to the machine, but sometimes the hose was burned; furthermore, the expense of maintaining a steam line out of doors to remote parts of the yard was a large item, so that other methods of heating were tried. In one of these, manifolds were placed in the top of sheet-iron pots, in which coal fires were kept burning. For use inside the ships, some manifolds were rigged up and heated by kerosene blow-torches and the shortest possible hose connection was placed between the heater and the machine.

Nearly all shipyards have used alcohol in the air-pipes in some way or another. One yard places five gallons of alcohol into the main receiver at one time. For a while there is perfect freedom from ice throughout the line, but this plan involves the shutting down of the air-compressor for several minutes, and, at best, is not effective for more than an hour. In some other yards, the injection of the alcohol is left to the individual initiative of the machine users. When a man becomes impatient from the delay, he obtains an order from his foreman to procure the alcohol from the storehouse; he then disconnects his hose and pours in some of the alcohol, thus relieving the ice situation for a short time.

In theory, heating the air is the best plan, but in practice it involves more trouble than the average man is likely to take. The use of alcohol is perfectly satisfactory from an operating point of view, but some convenient and economical provision for injecting it into the pipes should be provided. The objection may be raised that the mixture of alcohol and air may form an explosive compound; but this mixture is made every day and we do not hear of any explosions resulting. It certainly will not increase this danger to provide means of feeding the alcohol regularly into the air line instead of pouring in an excessive quantity and then doing without it for a period.

The accompanying illustration shows a convenient arrangement for feeding alcohol into the air line, which can be built at small expense and regulated to suit the demand. A short piece of 6-inch pipe *A*, capped on each end to make a reservoir, is fastened to a wooden horse *B* by a strap *C;* the reservoir is filled through a valve *D* on the top of the cap. A small pipe at the bottom is provided with a needle-valve *E* to regulate the feed; the valves sold for gasoline torches are suitable for this purpose. As it is necessary to know how fast the alcohol is feeding, means must be provided to observe the flow. A glass like that used in a sight-feed lubricator may be employed, but as this is likely to be broken a better method is to use a petcock *F* as indicated. When this petcock *F* is opened, the drip may be observed and adjusted; then, when it is closed, the alcohol will flow off at one side through the feed-pipe *G*. By using a number of these feeders near the terminals of the branch lines, instead of one large feeder on the main line, some advantages are gained. If this feeder is made of 1/8-inch flexible copper pipe, the connections may be made at any troublesome point without exact pipe fitting, and slight disarrangements will not break the pipe. In the feeder shown, an extra petcock *H* is provided, which may be opened when adjusting the drip valve to relieve any air pressure that may accumulate from the leaking of the shut-off valve *J;* otherwise, the unbalanced air pressure may cause the alcohol to drip faster while it is being adjusted than it will when the valve is closed. The small pipe *K* is necessary to maintain the pressure in the reservoir and to admit the air above the alcohol.

When it is considered that under bad conditions the machine operators may often waste from 50 to 75 per cent of their time because of frozen machines, it will be apparent that almost any reasonable expense or trouble that may be taken will be an economical measure if it removes the difficulty. The required amount of alcohol is best determined by test, gradually shutting down the feed to the minimum necessary to prevent freezing. It may be calculated by considering the capacity of the compressor and the degree of humidity, and then allowing about 25 per cent of alcohol for the water content. Any kind of alcohol may be used. Some other anti-freezing chemicals might be employed, but most of those that are effective have some objection to their use. Any oily substance is injurious to the rubber hose. Alcohol also is injurious, but as it is used only during the most severe weather and quickly evaporates, this objection is not of much practical consequence.

* * *

A locomotive was recently used to furnish steam to temporary steam pipes in a recently constructed Army Hospital, and this served efficiently in an emergency heating plant so that 1200 patients were comfortably quartered.

LETTERS ON PRACTICAL SUBJECTS

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CRANKPIN TURNING DEVICE

The crankpin turning device shown in Fig. 1 is designed to fit the spindles of a wheel quartering machine so that worn crankpins of locomotive driving wheels may be trued

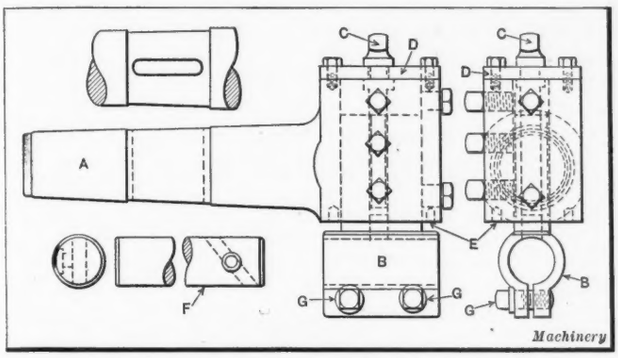


Fig. 1. Crankpin Turning Device

while in place without the necessity of pressing them out and turning in a lathe or truing them by filing. With the device shown, the turning of these pins can be quickly and accurately accomplished on the ordinary wheel quartering machine, such as nearly all locomotive construction shops are equipped with. The wheel quartering device which is ordinarily used for boring crankpin holes in mounted locomotive driving wheels is so designed that the holes can be accurately bored to size and properly quartered in one operation.

It is evident that in simply fitting the spindles of this machine with holders for turning tools, in place of the regular boring-bars, corresponding accuracy will be obtained in the turning operation. Part *A* fits into the spindles of the wheel quartering machine; the opposite end is rectangular in shape, 5⅛ inches wide, 6 inches long, and 4½ inches thick. This is slotted out 1½ by 3½ inches to receive toolpost *B*, which is adjusted by moving it in or out to suit the diameter of the crankpin by means of screw *C*. When an extra large pin is being turned, the plate *D* can be placed on the opposite side at *E*, which throws the toolpost *B* farther out from the center of the spindle. Both ends of the rectangular portion of *A* are tapped for ⅜-inch cap-screws to allow plate *D* to be fastened in the required position. Five set-screws, as shown, keep the toolpost from moving, but generally only three are required in actual use. The part *B* that holds tool-holder *F* is split so that clamp bolts *G* will grip it rigidly. Tool-holders *F* either 14 or 21 inches in length are used, depending on the length of crankpin to be turned. The tool slot in *F* is made at an angle in order to bring the tool up close to the fillet or shoulder. One 1/2-inch set-screw holds the tool in place. The end of screw *C* is made square so that it can be easily adjusted with a wrench. All parts of the tool are made of steel and are accurately machined.

Fig. 2 shows the wheel quartering machine with the work and crankpin turning device in place. M. K.

MAGNET FOR CLEANING CHIPS FROM HOLES

Many uses have been found in the modern machine shop for electricity and new applications are continually being made. One of the latest uses is the magnetizing of devices for cleaning out holes in planer platens, T-slots, jigs, etc., where the dust raised by compressed air is objectionable or a menace to the health. The accompanying illustration shows a tool for removing chips, etc. It consists of a core *A* of No. 24 B. & S. gage annealed iron wires, which should be as straight as possible so as to make a compact bundle of the given diameter. This core is magnetized by the coil *B*, which consists of five layers of No. 22 B. & S. gage double-cotton-covered magnet wire. The paper covering *C* for both the coil and its core should be wound with black cotton thread and covered with shellac. Fiber washers *D*, bored small enough to press onto the core, make a sort of spool for the magnet wire, which should be carefully wound to make a neat job. The core is then pressed into the handle *E* about an inch. This handle contains the wires *F*, which can be of the same size wire as the core. The wires enter the coil through two small holes drilled through the handle and two corresponding holes drilled in the fiber washer. A

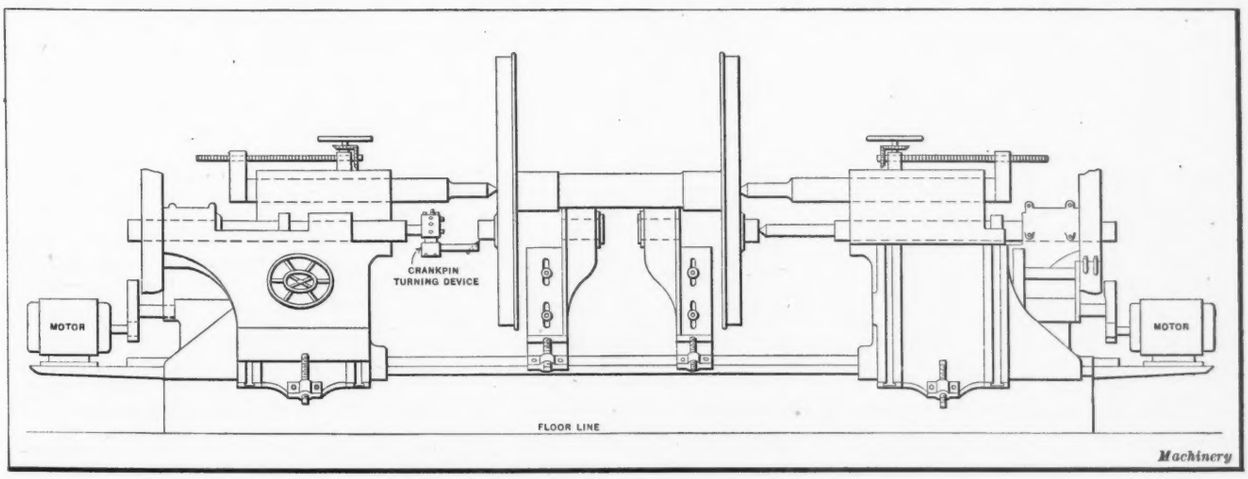
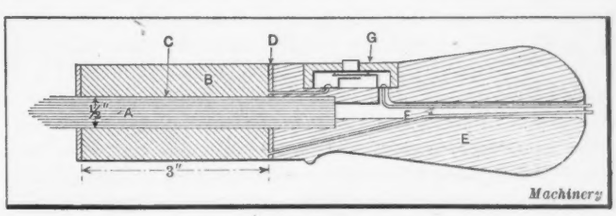


Fig. 2. Wheel Quartering Machine with Crankpin Turning Device in Place



Device for cleaning Chips from Holes

push-button *G* is provided so that the circuit is complete only when the button is held down; a button suitable for this purpose can be obtained at any electrical store for a few cents. The tool may be operated by four dry cells, which can be mounted in a box convenient to the machine on which the tool is to be used and connection made from the box to the tool with common lamp cord. All that is necessary in operating the tool is to bring the point of the core in contact with the chips and press on the button, when the chips gather on the end of the magnet; they are released when the contact is broken by releasing the pressure on the button.

Jackson, Mich. RICHARD GIBBS

JIGS FOR MACHINING A ROLLER SHIFTER

This article describes the construction and operation of two interesting jigs designed for use in machining the roller shifter shown in the illustration at the upper left-hand corner of Fig. 1. The first operation is the drilling of the hole *A*. It is essential that this hole be not only in the exact center of the boss but that it be at right angles to the flat U-shaped part of the shifter as well. Special care is required in drilling this hole, as it must be accomplished in such a way as to avoid any possibility of the work bending under the pressure exerted by the drill, as the casting, in that case, would subsequently spring back and fail to give the desired result.

The jig for performing this operation is shown in Fig. 1. It consists of a cast-iron base *B*, on which two bosses *L* and *K* are cast. The latter is provided with a screw *E* and a large washer *D*. The washer is constantly pressed upward against the nut on *E* by a spring *F*. A bracket *C*, securely fastened to *B* as shown, serves to hold a sliding bushing *H* which can be held in any position by a set-screw *M*. In line with the center of this bushing is another bushing *I* which slides in base *B* and which may be held where desired by means of set-screw *N*. Boss *L* has a hardened steel V-block *G* secured to it by machine screws and dowel-pins. In line with the center of this V-block as well as with bushing *I* is the fastening screw *J* provided in bracket *C*. The U-shaped part of shifter *A* is laid upon boss *K* and its boss is located properly in V-block *G* where it is held by screw *J*. Clamp washer *D* is then forced down by the nut on stud *E* so that the flat surface of *A* is securely held against *K*. V-block *G* is made so narrow that it cannot interfere with this operation. Bushings *H* and *I* are now pushed against the boss of *A* and secured in that position by screws *M* and *N*, respectively. As the pressure of the hand in bringing these bushings against *A* is not nearly sufficient to bend the latter, and as the fastened bushings securely hold the shifter in the correct position while drilling, it is clear that every piece will be drilled accurately.

The second operation is the milling of both sides of the flat, U-shaped part of *A* as indicated by dotted finishing lines *F* shown in the view of the shifter in the left-hand corner of Fig. 1. This is done with the jig shown in Fig. 2. The base *B* of this jig is made of cast iron and has two long projections *J* and *C*, the latter being reinforced by two ribs *O*. Projection *C* is also provided with a round finished and hardened steel pin *D* extending equal distances beyond the sides of *C*. Hardened adjusting screws *K* are screwed into each side of boss *J* and may be secured by a lock-nut as shown. In line with these screws are clamping screws *G*, provided in steel arms *E*. Arms *E* swing about screws *F*, but a nose *W* resting on base *B* insures the coincidence of screws *G* and *K* after arms *E* are swung in. A two-armed steel bracket *H* is held to the flat top of *J* by screw *L*. Each of its arms is equipped with a hardened clamping screw *M* the latter having a loose pressure washer at the end as shown. Lugs *N* assure the placing of the jig on the milling machine table at right angles to pin *D*.

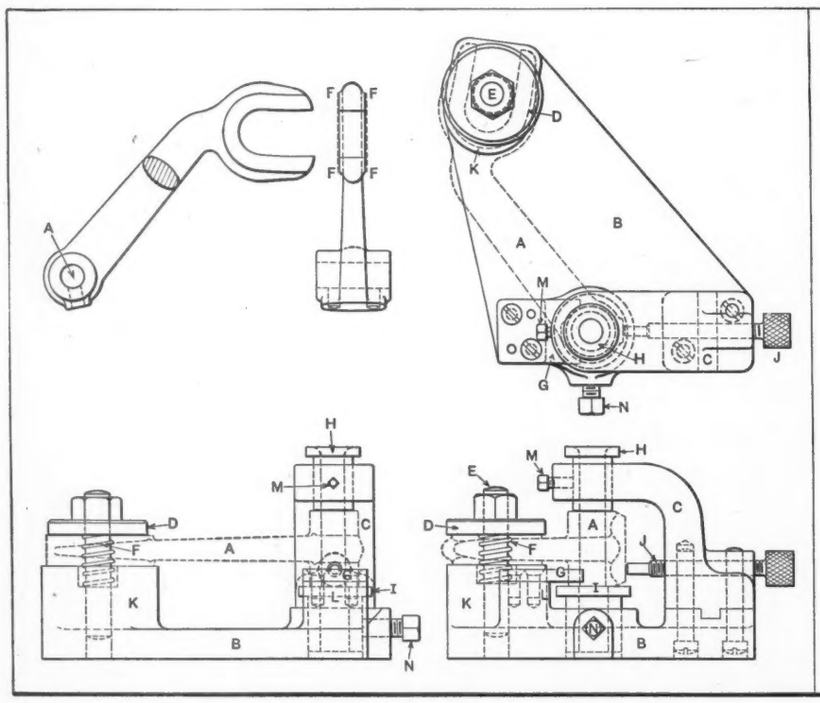


Fig. 1. Roller Shifter and Jig for drilling it

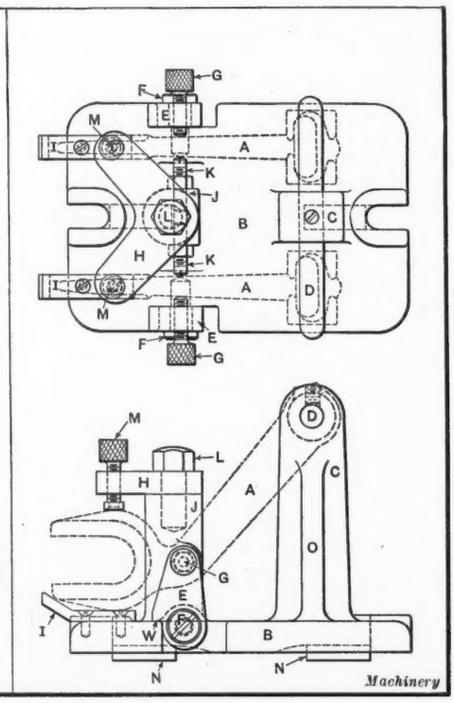


Fig. 2. Jig for milling Roller Shifter

To use the jig, arms *E* are swung out and a shifter is slipped on each side of pin *D* and pushed on until their sides rest against screws *K*. The latter are so adjusted that the center line of the unfinished oval arm of *A* coincides with the centers of gages *I*. Arms *E* are then swung back and screws *G* are tightened. As screws *G* are now exactly in line with the screws *K*, there is no bending moment and consequently no strain or tension exerted which would cause *A* to spring back after being milled. Screws *M* are screwed down lightly to prevent any chattering. Four cutters properly set and adjusted according to hardened steel gages *I* will finish two shifters in one cut. The jig is absolutely reliable and works very quickly and accurately.

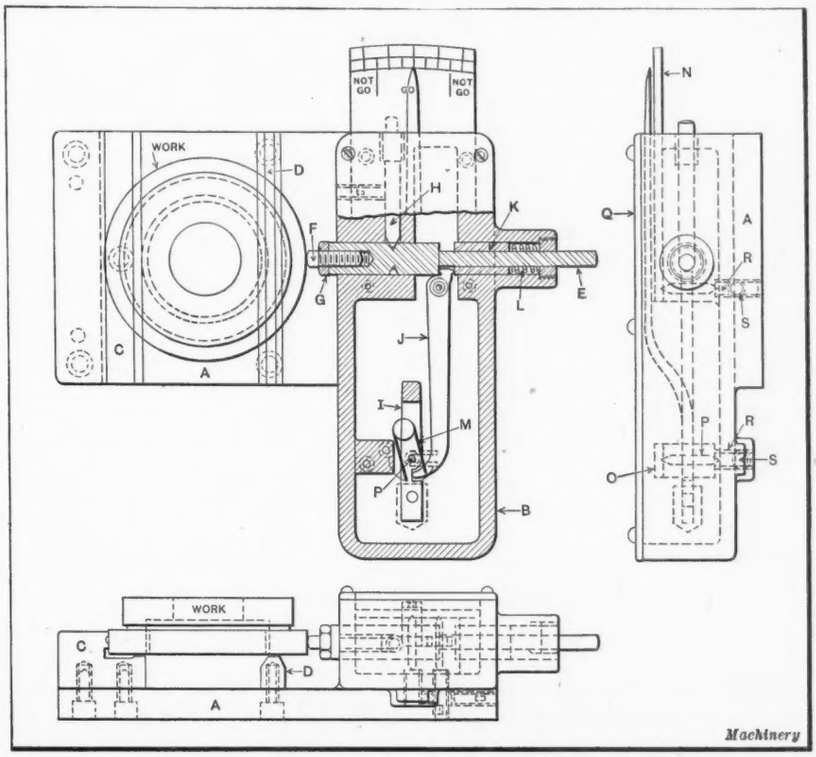
West Reading, Pa. CHRISTIAN F. MEYER

INDICATOR FOR GAGING SHELLS

The accompanying illustration shows an indicator designed by the writer for determining the outside diameter of the heads and bases of trench mortar shells. It performs the same function as a micrometer, inasmuch as it shows the operator of a machine just how near to either the maximum or minimum limit his work is being machined; but it has the advantage of being much more rapid in its operation. A movement of 0.001 inch on the anvil is increased to ⅜ inch at the end of the indicating needle.

A single iron casting forms the base *A* and mechanism case *B*. The pieces *C* and *D* are hardened slides for the work to rest on. *E* is a hardened and ground steel plunger, tapped at one end to take the adjustable anvil *F* which is locked in place by nut *G*. This plunger has a ground V-groove in which plug *H* terminates. The plug is adjusted in the groove so that needle *I* will be held at the center of the scale; the plug is then loosened to permit 0.0015 inch movement of the plunger or 9/16 inch movement of the needle and locked in place by a set-screw.

The lever *J* is mounted on pivot bearings and bears against plunger *E*, being held in contact by collar *K* and spring *L*. From the point where *J* bears on plunger *E* to the center of the pivot bearing it is ¼ inch and from the center of this bearing to the end that bears on indicating needle *I* it is 3 inches, thus giving a movement of 12 to 1. The indicating needle *I* is mounted on hardened pivot bearings and is counterweighted. From the point where lever *J* makes contact with this needle to the center of the bearing it is ¼ inch and from the center of the bearing to the point of the needle it is 7¾ inches, giving a movement of 31 to 1 or a ratio of 372 to 1 between the anvil and the needle point. *M* is a light spring which holds the needle and the lever together. *N* is a steel plate which carries the scale and which is prick-punched to form the upper bearing for the lever pivot. This fits snugly in the base and is firmly doweled and screwed in place. The scale is calibrated with standard plug gages after the indicator is assembled. The small steel piece *O* forms the upper bearing of the needle pivot *P*. *Q* is a plate covering all the mechanism and having only a 3/16 inch opening between it and plate *N* through which the needle projects. The lower ends of both pivots are seated in headless set-screws *R*, which are locked in place by set-screws *S*, set in at right angles to them.



Indicator for gaging Outside Diameter of Trench Mortar Shells

Two of these indicators were made up, and they gave such good results that all the machines on this operation have been equipped with them. With a slight change in the mechanism case, and the addition of a diamond point and spring lever to hold the point away from the work, this indicator may be readily adapted to gaging work on a lathe or grinder while the work is in motion.

Flint, Mich. T. L. STALKER

HOT TINNING OF IRON AND STEEL

Tinning is like plating, inasmuch as the surface of the iron or the steel to be tinned must be free from oxide. The slightest particle of scale or rust on the surface will prevent the tin from adhering to this particular spot. To remove the rust and scale from the surface of the iron or steel to be tinned, pickling must be resorted to. The pickle that is the most satisfactory and the cheapest is oil of vitriol (sulphuric acid). This is used in the proportion of nine parts of water and one part of acid and makes what is known as a dilute acid of pickle. Strong sulphuric acid will not act upon iron at all, and it is carried in iron tank cars. As soon as water is added, however, it will attack it. The proportion of nine parts of water to one part of acid has been found excellent for ordinary pickling.

The articles to be pickled should be free from grease or oil for the reason that the acid will not attack a greasy surface. Grease may be removed by tumbling in sawdust, cleaning in benzine, or in a hot potash or lye solution, depending upon the kind of goods. Some goods or those which are clean can be pickled directly. All work should be pickled, no matter whether it may look clean or not. A bright surface may have a bright appearance, but still have a film of rust on it that will prevent the adherence of the tin. In this case, however, only a very short pickling is required. The pickle is made up by adding sulphuric acid to the water. If water is added to the sulphuric acid so much heat will be generated that the water with some of the acid will be thrown out of the vessel in which it is placed on account of the boiling which will follow. Always pour the acid *into* the water and stir while it is being poured. Heat is generated, of course, but this will not do any harm. The pickle works more rapidly, when it is warm, and when a pickle is desired that will work quickly and to the best advantage, means should be had for heating it up. A coil of lead pipe, through which steam can be passed, is the best method of heating the pickle. A temperature of from 120 to 150 degrees F. is suitable. The pickle may be held in a stone crock if a small quantity is used, but in large quantities a lead-lined tank is better, although an unlined wooden tank may be used. The lead lining is preferable, however. The lead should be thick enough to guard against puncture, should articles drop into the tank, and the seams should be burned together and not soldered, as solder soon becomes eaten away by the acid.

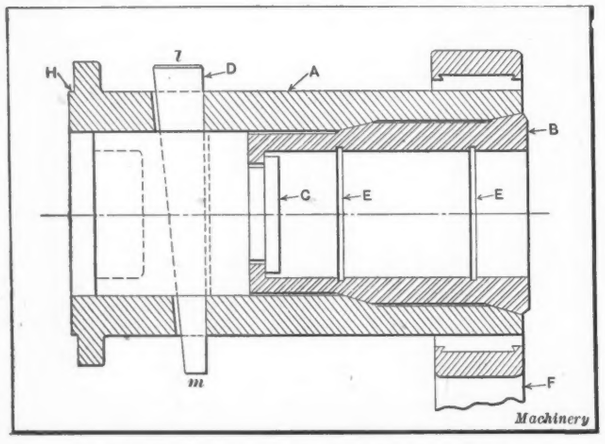
The pickling of the iron or steel articles is effected by immersing them in the acid. The pickle removes the scale or rust and only slightly attacks the iron or steel base. The length of time required for the pickling depends upon the amount of rust or scale present. If there is only a little rust, the pickling may take but five or ten minutes, but if

scale is present, a longer time is required, as it does not dissolve so easily. When the scale has been removed, which can be ascertained by inspecting the articles, they should be removed from the pickle so that no further action will take place to roughen or pit the surface of the iron or steel. To prevent the articles from rusting again before tinning, in case it cannot be done immediately, they should be rinsed thoroughly in *cold* water to remove the acid which adheres to them, and then, *without drying*, immersed in a solution of sal-soda made by dissolving one pound of sal-soda in a gallon of water. If the articles are kept immersed in this, they will remain almost indefinitely without further rusting, but if they are allowed to dry after pickling and rinsing, rusting will immediately follow. It will also follow if hot water is used for rinsing, as it will dry off from the surface almost immediately, leaving a dry surface. Dry surfaces, of course, always rust if the metal is chemically clean.

Liverpool, England MARK MEREDITH

WEDGE CHUCK FOR 4.5-INCH HIGH-EXPLOSIVE SHELLS

The chuck shown in the accompanying illustration was designed for holding 4.5-inch high-explosive shells, and its use resulted in an increased production by a large concern having a contract for this size shell. The opening and closing of the chuck jaws can be accomplished very quickly, and it is this feature which makes it particularly adapted for this type of work. To close the jaws upon the work, it is only necessary to give the wedge *D* a light blow with a hammer at



Wedge Chuck for 4.5-inch High-explosive Shells

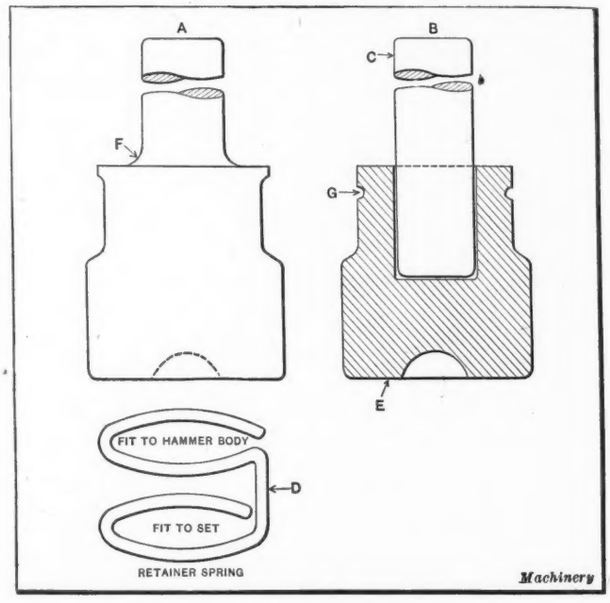
point *l*. To release the jaws, a light blow is given the wedge at point *m*. The chuck can be installed with little expense and will be found satisfactory when it is not convenient to use air-chucks, and the cost of upkeep is almost negligible.

It is composed of the main body *A*, having a flange which allows it to be fastened to a faceplate. The faceplate should be counterbored to receive the boss at *H* so that perfect alignment may always be insured. The collet *B* is split with a 1/8-inch saw into three pieces, which are kept in the expanded position by the two piston rings *E*. The collet is actuated by the sliding block *C*, which has a rectangular taper slot cored in it to receive the wedge *D*. The wedge has given the best service when made of a cheap grade of tool steel, having the ends hardened and drawn to a blue color. This type of chuck requires a steadyrest *F* which makes it very rigid. Where the lathe has a quick change from high to low speed, the chuck can be controlled while running without stopping the spindle, and piece-workers soon learn to take advantage of this feature.

Medicine Hat, Alberta, Canada JOHN HOMEWOOD

PNEUMATIC TOOL SET

The shank of the special two-piece pneumatic tool set shown at *B* in the illustration was designed to overcome the



Two-piece Pneumatic Tool Set

constant breakage at *F* of pneumatic hammer sets of the common single-piece construction, such as shown at *A*. Although the cost of production is slightly greater than that of the solid type of tool, its construction is warranted, since the advantages derived from better construction permit greater speed in setting down rivets and staybolts, and in belling flues, which amounts to a saving of 50 per cent in time. This tool also effected a considerable saving in tool steel, as breakage was reduced to a minimum.

The shank *C* and body *E* are made of bit steel of about 0.70 per cent carbon content, and are water-hardened and tempered in oil, the section at groove *G*, in which the retaining spring *D* fits, being slightly softer than the rest of the body. One end of the 3/16-inch diameter retainer spring *D* is snapped onto the hammer body, and the other end into groove *G*, which enables the tool to be shifted around without dropping off.

Los Angeles, Cal. E. DOYLE and A. RETHEY

JIG FOR DRILLING A NOZZLE

Recently it was necessary to make a jig for drilling the nozzle shown in Fig. 1, which has three outlets. The outlet *A* on the top is 1/2 inch in diameter and the two outlets *B* on the sides are 3/16 inch in diameter and located at an angle of 62 degrees with the center line. The inlet *C* is tapped to receive a 1/2-inch pipe. The first operation is to drill the center outlet *A* and then drill and tap the inlet *C*. This is done on a turret lathe having a two-jaw revolving chuck which enables the operator to change the position of the work without actually removing it from the chuck. Then the oulets *B* on the sides are drilled, this operation being done in the jig shown in Fig. 2. As it requires but little more material, work, and time to make a jig that will hold two or more of the pieces to be operated on than to make a jig that will hold only one, this jig was made to hold two nozzles. The work is done on a 23-inch drilling machine

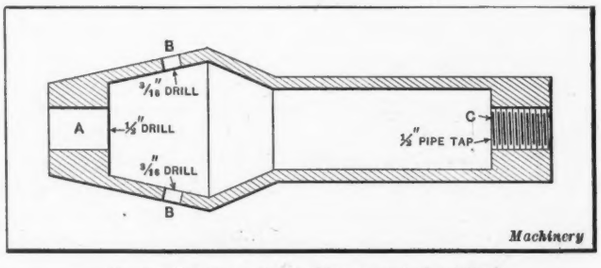


Fig. 1. Nozzle in which Holes were to be drilled

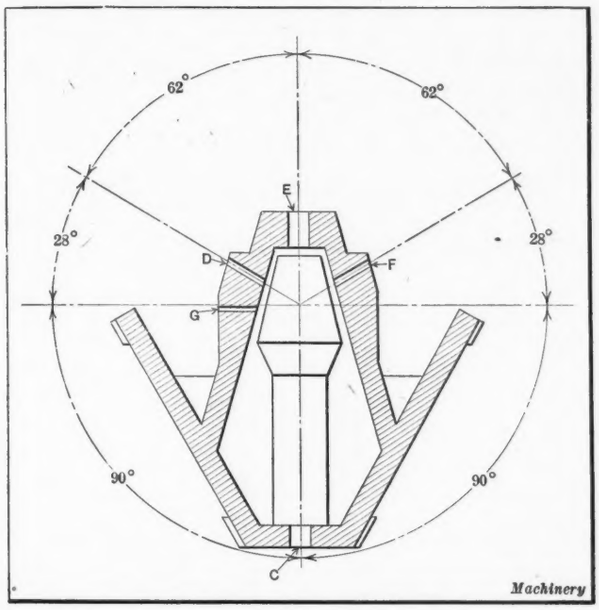


Fig. 2. Jig for drilling Holes in Nozzle

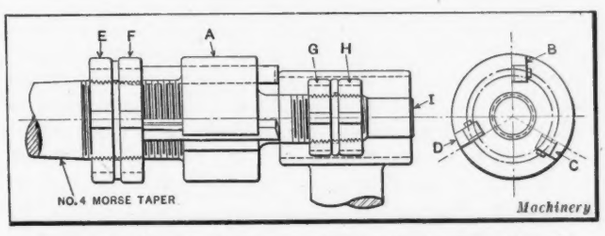
with a double drill attachment, the work being drilled from both sides of the jig.

After the jig casting was milled and shaped to dimensions, it was plugged; in other words, a plate was made to fit one side and then a center line or axis was found, as shown. When this axis was found, the casting was laid on a faceplate and screwed to the dividing head of a universal milling machine, the actual center line or axis being indicated so as to be perfectly central with the dividing head. The casting was then squared and aligned with the milling machine and the index was set. After hole *C* was bored, the dividing head was brought into position for boring hole *D*, which is at an angle of 90 degrees plus 28 degrees with the axis of the first hole *C*. When this hole *D* was bored, the jig was turned through an angle of 62 degrees into position for boring hole *E*, and after this was bored the jig was turned through another angle of 62 degrees and hole *F* was bored. The table was then lowered and the holes in the other end of the jig, which are spaced in the same manner, were bored. The holes *G* for the clamping and centering fork were then drilled on a drilling machine. To hold the work securely, a small lug projects from the jig, which fits into the tapped end of the nozzle at *C*. The other end of the nozzle is held by a pin at *E*, which has a shoulder and is clamped by means of a hand-nut and plate.

St. Louis, Mo. THOMAS I. KRAUSKA

TOOL FOR FACING ENDS OF BOSSES ON AIRPLANE ENGINE CONNECTING-RODS

In the accompanying illustration is shown a type of facing tool that is being extensively used in the shops of a large company manufacturing airplane motors. This particular tool is designed for facing bosses on the wrist-pin end of airplane engine connecting-rods. It is of simple construction, and when accurately machined gives dependable service. It consists of a soft steel body *A* having a taper shank which fits the drilling machine spindle. There are three slots milled in the body *A* at points *B*, *C*, and *D* to receive the high-speed steel blades. These blades are held in place by means of a key milled on their sides, which fits snugly in the keyways in slots *B*, *C*, and *D*. This method of holding the cutters eliminates the necessity of using screws which work loose and cause considerable trouble. The adjustable nuts *E* and *F* locate the blades, and adjustable nuts *G* and *H* act as a stop for governing the facing depth. The end of the body at *I* is hardened and ground and acts as a pilot.

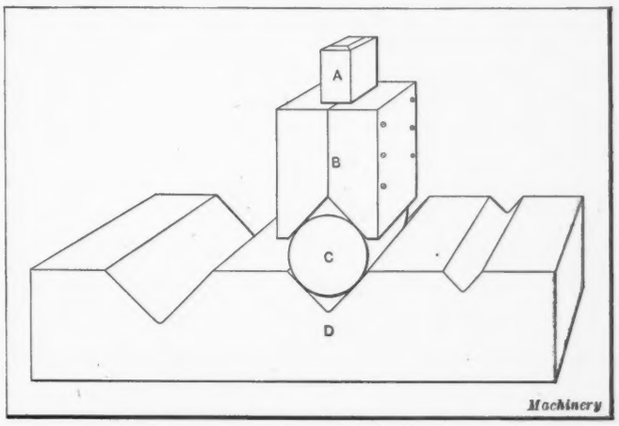


Tool for facing Ends of Bosses on Airplane Engine Connecting-rods

New Brunswick, N. J. C. H. DENGLER

FINISHING PLUG GAGES

In making plug gages, and even thread gages, low-carbon steel is now very commonly used, the stock being machined for grinding and the threads rough-cut previous to the stock being carburized. In many cases only the handles of such gages are made of this cheaper material which for this purpose requires no hardening. When this cheaper metal is used for the handles, the work may be darkened by the regular heat-treating process to remove the contrast of the two grades of material. This finish is not to misrepresent the quality of the metal but to give the work an appearance of uniformity and good workmanship. The smooth part of the knurled handle should be brightened by the use of emery cloth after treating. Recently the writer inspected $40,000 worth of new gages that were remarkably accurate, but had a crude appearance, largely because of the failure to darken the low-carbon steel. The contrast between the bright and the dark surfaces of the soft and hardened metal seemed to be continually calling attention to the cheaper material in the handles.



Holding Punch in Alignment when lettering Round Work

Knurling in all cases will have a more clear-cut appearance on gage handles if the smooth part at the end is turned slightly smaller than the knurled diameter, as for example, the thimble of micrometer calipers. Another important feature as regards the appearance of plug gages is the lettering. One of the most common complaints seems to be the failure on the part of some firms to provide good and complete sets of letters and figures, and to see that these are well taken care of. In one Eastern tool shop, only the employes who are specially experienced do the stamping. No experimenting is permitted on the gages; the new men practice on scrap material. Each of the workmen is provided with the necessary sets of letters and figures, and is responsible for their proper care. For words and phrases, such as "go," "not go," "master," or name of firm, special punches are provided. To use a punch for each letter makes it difficult to keep each letter in alignment, and better and quicker work is done with a special punch.

The arrangement shown in the accompanying illustration keeps the punch in alignment with the axis of a round piece of metal that is to be lettered. The punch *A* is a snug fit in the holder *B*, which rests on the work *C*. The V-block *D*

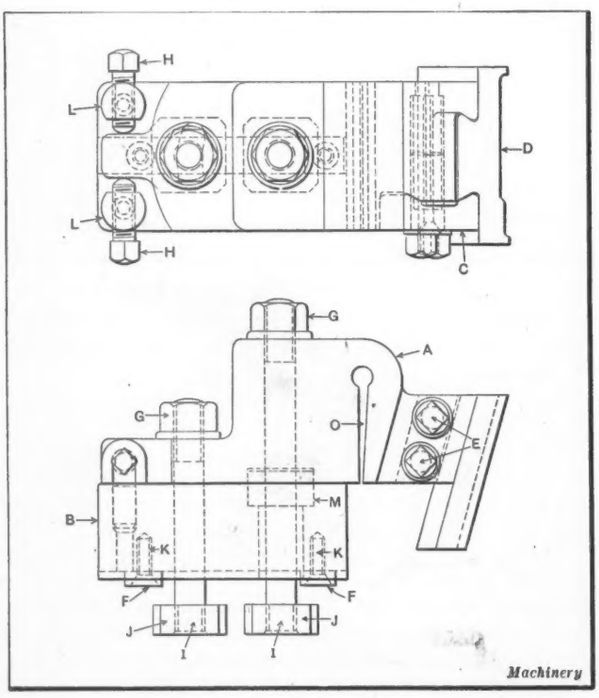
may be of hard brass. From a business standpoint, to spend hours lapping the various parts of gages to a high degree of accuracy, and then pay scant attention to those points that make for real finish is an unwise procedure.

New York City E. J. HIGGINS

SPRING FORMING-TOOL HOLDER

The forming-tool holder shown in the accompanying illustration may be used in an engine lathe, screw machine, or any machine where wide forming tools are used. It is especially designed to eliminate all chatter, and can be made any size to meet requirements. The part *A* is made of tool steel, and is hardened and drawn to a spring temper. The bottom of this piece is ground to a good surface where it bears on the cast-iron base *B*. The clamp *C* which holds the forming tool *D* is ground on both edges where it comes in contact with the part *A* and forming tool *D*. This clamp is rigid and has great holding power, as there is no spring tension to be overcome by screws *E*. When the tool is made secure in the cross-slide and the tongues *F* are well fitted, the forming tool can be easily and accurately brought into line with the work by loosening nuts *G* and setting the tool *D* with set-screws *H*. The hold-down bolts *I* are made of cold-rolled steel and threaded on both ends; the heads *J*, made to fit in the T-slots of the cross-slide, are screwed to the bottom ends of the bolts, after which the bolts are peened over to hold them in place. This method of making the bolts is much cheaper and almost as strong as if they were turned down from one solid piece. The tongues *F* are secured by screws *K*. The studs *L* are made of cold-rolled steel. A hardened and ground bushing *M* is a drive fit in *B* and a wringing fit in part *A*; this eliminates all shearing strain on the bolts while the tool is being fed into the work.

The front clearance of this tool should be no less than 15 degrees, which is a good practical angle for a tool of this



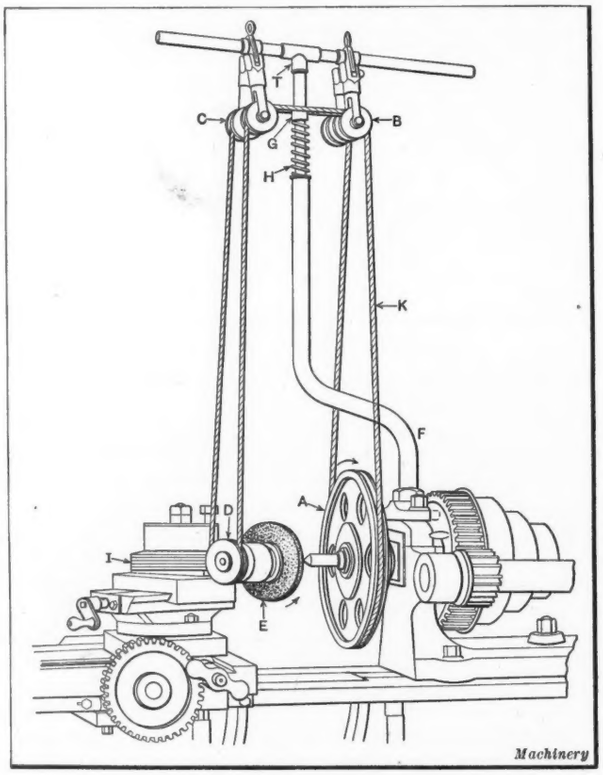
Spring Forming-tool Holder

kind. This tool can be easily ground on a surface grinder by removing part *A* from *B* and placing it on the magnetic chuck of the grinder. The top surface of the forming tool can then be ground to produce the sharp cutting edge that is required. This method of grinding is simple, and the accuracy of the profile is insured. The saw slot in *A* at *O* is cut after the other machining of the piece is completed. After being heated to a red heat, the slot is brought together, thus eliminating any excess spring in the tool-holding portion of *A* when the tool is fed into the work. This tool is particularly useful for backing off forming cutters in a lathe, as it insures smooth cutting.

New Haven, Conn. ADOLPH STARR

CENTER GRINDING ATTACHMENT

In the accompanying illustration is shown a center grinding attachment which proved very satisfactory. The emery



Center Grinding Attachment

wheel is driven by a gut band *K* from a grooved pulley *A*, which is screwed to the spindle nose. The band *K* passes over the guide pulleys *B* and *C* to the small pulley *D*; at the opposite end of the spindle to which *D* is attached is located the emery wheel *E*. The stem of the part *T* fits into the upper part of the arm *F* and can be adjusted vertically to suit the tension required by the gut band. When the correct position of part *T* has been obtained, collar *G* is secured by a set-screw in such a position as to compress the coil spring *H*. The holder *I* is fitted in the tool-rest, and the emery wheel is fed by means of the slide-rest across the conical point of the lathe center. The wheel revolves at a high rate of speed and will sharpen a lathe center in a few minutes.

Brooklyn, N. Y. A. J. CAHEN

NEUTRALIZING THE EFFECTS OF COLD WEATHER

Two serious problems are often met with in drafting-rooms during the winter time. The damp, cool air dries the ink very slowly, so that the draftsman may be compelled to waste considerable time waiting; it is often so chilly in the small drafting-rooms that the draftsman's hands become too numb for good lettering. Of all the men in a plant or office, the draftsman's, and especially the tracer's, hands need to be warm if good work is to be done. An electric fan equipped with heating coils turned down upon the work will not only keep the hands warm but dry the ink when tracing so rapidly that in many cases the draftsman can turn out twenty-five per cent more work.

Fort Wayne, Ind. G. G. STEVENSON

SHOP AND DRAFTING-ROOM KINKS

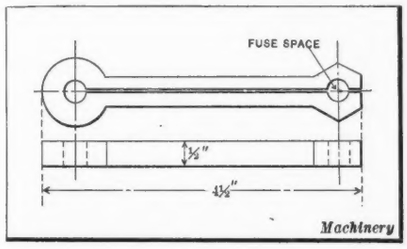
OIL STAINS ON CONCRETE FLOORS

Oil stains on concrete floors may be removed by using a mixture of 1 pound of oxalic acid in 3 gallons of water, with enough wheat flour added to make a paste that can be applied with a brush. Allow the application to remain for two days, and then remove it with clean water and a scrubbing brush. A second application may be necessary in stubborn cases.

M. E.

FUSE TONGS

The accompanying illustration shows a simple yet valuable tool that may be used in removing or replacing fuses such as fit into clips. There is some danger attendant upon handling these fuses, especially in damp places or when there is no insulation between the hands and the line. The construction of the tool is so simple that a description is hardly necessary. It is made of fiber, having two holes drilled as shown. After the holes have been drilled, the outline and then the slot are cut with a band saw, and the rough edges finished off with a file.



Fuse Tongs

Youngstown, Ohio

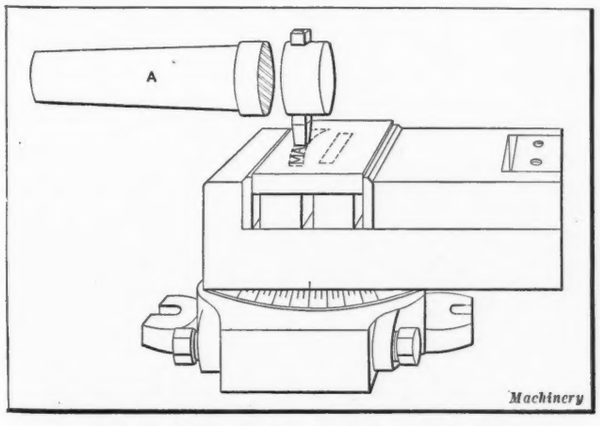
MAURICE CLEMENT

LETTERING FLAT WORK ON MILLING MACHINE

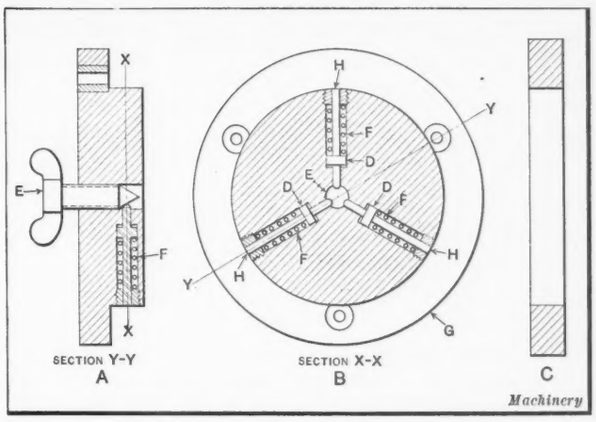
The accompanying illustration shows an accurate method of lettering on flat work. The lettering is done on a milling machine, using the vise as a holder for the work and the arbor *A*, with a square hole in one end, as a punch-holder. The punches are ground to fit the hole in the arbor. The work rests on two parallel blocks in the vise. The workman spaces the letters by using either the graduations on the vise or the index dial on the feed-screw, according to whether the lettering is to be arranged in a straight line or radially. If it is arranged radially, the central letter of the line is made first, so that the vise may swivel to each side of the center, on a set radius.

New York City

E. J. HIGGINS



Utilizing Milling Machine for lettering Flat Work



Jig for drilling Ring

JIG FOR DRILLING RING

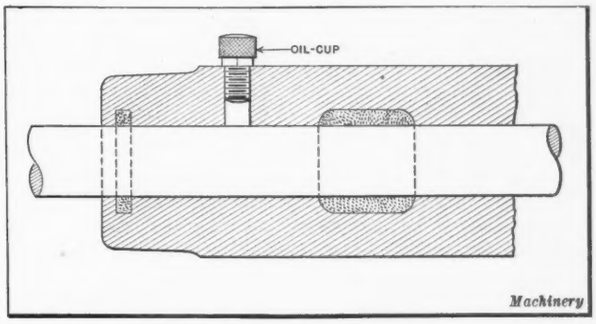
In the accompanying illustration, at *A* and *B* is shown a jig for use in drilling the ring shown at *C*. Referring to the illustration at *B*, it will be seen that there are three plungers *D* held against the conical point of wing-screw *E* by springs *F*. In operation, the wing-screw *E* is turned back until the plungers *D* are just within the body *G* at points *H*. The ring *C* is then slipped on and the wing-screw turned down until the plungers *D* are forced out and into contact with the inside surface of the ring. The ring is then drilled on a sensitive drilling machine.

York, England

JOHN SCOTT

LUBRICATING A COUNTERSHAFT

A simple and effective method of furnishing proper lubrication for countershafts is shown in the accompanying illustration. The bearing should be placed in a lathe chuck and recesses cut as shown. There should be one in the center of the bearing, about 1 inch in width, and one approximately 1/4 inch wide about 1/8 inch from each end. The recesses should be slightly less, say 1/16 inch, than the thickness of the felt that is used in them. The bearing is drilled and tapped for the oil or grease cups, preferably grease cups since they are less expensive and more suitable for this method of lubricating. Pieces of felt are then cut cone-shaped and pressed into the hole of the cup, which, of course, is filled with oil. The felt acts as a wick, and shafts thus lubricated will run from three to four weeks on a single supply of oil. Felt strips are also put into the recesses at the ends of the bearing to prevent the oil from leaking out.



Method of Lubricating Countershaft

Yonkers, N. Y.

EUGENE BILGER

Industrial Reconstruction

Readjustment—Government War Order Policy—Foreign Trade—National Reconstruction Activities—Method of Handling Reconstruction Problems in Great Britain

READJUSTMENT

BY ALEXANDER LUCHARS[1]

Most business men who are familiar with the extent to which the manufacturing industries of the country were dependent on war orders have been surprised and encouraged at the progress of stabilization since the war ended. That we must pass through a period of readjustment when peace came, has long been evident; and although few expected it to come so suddenly, almost every manufacturer has been trying to provide for its arrival.

The National government has assumed the initiative by arranging, so far as practicable, for the gradual discontinuance of contracts now in manufacturers' hands, and indirectly for those with machine tool builders, as nearly all the machine tool orders were placed by contractors for government work and not by the departments directly. The government is endeavoring to avoid disturbing industry, and especially labor, by sudden cancellations of war orders, and this policy is being carried out wherever practicable, so far as we can learn, in spite of reports to the contrary. Orders placed by government contractors have been cancelled or suspended, but without the sanction of the departments. The cancellation of large amounts of war orders mentioned in the newspapers appear to refer principally to the program for 1920, to orders not yet placed, to orders placed since October 1st last, and to material of which there is a large supply in excess of requirements.

The policy of the government, as officially stated, is "to allow labor now employed on war materials to find its way back to former occupations without much loss of time, and at the same time to avoid serious injury to the contractors who for months past have loyally given their best effort to help the government supply the needs of the army and navy." A further official statement is that "Orders for partial or complete suspensions of work and a selection of particular contracts to be affected will depend not only on actual requirements, but on the proper distribution of such contract alterations, having in view the interests of contractors and subcontractors, as well as labor, material and general economic considerations."

To assist manufacturers and contractors in adjusting without delay their claims against the Ordnance Department, a Claims Board has been appointed with authority to pass on each contract on its merits, allowing a "just and reasonable compensation by reason of the suspension or termination of a contract or order." When an immediate settlement is agreed on between the various parties interested we are informed that the government intends to pay the amount allowed without delay. When a full settlement cannot be agreed upon, the amount that is agreed upon will be immediately paid and the remainder left for the decision of the Claims Board. This Board will have representatives in every ordnance district in the country, with authority to make or recommend settlements, saving manufacturers the trouble and expense of going to Washington.

I have talked with more than a dozen manufacturers representing as many different industries, who have been selling their entire product to the government, and not one of them is disturbed by present conditions. A typical case of rapid readjustment is that of the largest cork manufacturer in the United States, whose factories have been running days, nights and Sundays on cork for gas masks, and who told me that all his government contracts had been cancelled, but he was perfectly satisfied, because he had enough orders from his regular customers to keep him running well into the Spring. Is there any industry you can think of that seemed more likely to be injured by the ending of the war? It is true that machine tool manufacturers are not generally in this position; but if they will "carry on" for a few months the future will look different. Don't forget how things looked in 1907.

It becomes apparent that the enormous expansion in the use of machinery during the war period will incline millions of people towards mechanical pursuits who never before had a mechanical idea, much less any mechanical experience; and this is certain to result in a great mechanical era, not only for this country, but for the world.

Of the unprecedented sums we have raised and are yet to raise by taxes and loans, all will not be lost or wasted. Whatever the net cost is, we shall carry it in the form of taxes for a generation or more, which means, not necessarily a diminution of business activity, but high cost levels for labor and material.

Our loss of life—let us say it with thankfulness—is small compared with that of the European nations, and this must be a factor in the comparison of labor costs between this country and Europe; because the shortage of labor is certain to be relatively more acute there on account of the greater loss of life. This seems like a cold-blooded way to look at the situation, but this feature of it must be taken into account.

The $900,000,000 program for railway equipment will probably wait for lower prices; but we all know that during the past three years our markets have been almost stripped of machinery, appliances and supplies, other than those used for or to produce war material, and those must be replaced to meet normal demands. Our manufacturers will now invest some of their surplus earnings in re-equipping their own factories, and their designers will have time to work out new ideas, based on their war manufacturing experience. These United States will make some wonderful strides in mechanical development during the next few years, and every such advance will strengthen our hold on foreign markets.

As labor comprises a considerable part of the cost of all manufactured products it is only fair that it should help in the readjustment. In the writer's opinion, we shall never again see the costs of either labor or material where they were in 1907, or even in 1913; but both are now too high to permit a general readjustment of business. Labor costs on munition work have reached incredible figures, and many industries in no way connected with war work are paying wages which make any profit impossible under normal conditions. Allowed to readjust themselves, the business interests of the country will soon return to normal conditions and take a new start towards continued prosperity; but the attitude of labor will be the determining factor in the situation and it is idle to ignore it.

[1]Publisher of MACHINERY.

AMERICAN SALES ENGINEERING IN THE EXPORT FIELD[1]

By S. T. HENRY, Vice-president, Allied Construction Machinery Corporation, New York City

LARGE and permanent export markets for standard American engineering machinery can be built up abroad by the introduction of American methods of using such machinery. The introduction abroad of American industrial methods was until recently a slow and tedious process. Several large American manufacturers had, however, conducted such introductory work with marked success. They had sent into various countries of the world sales engineers who were well grounded in the use of their machinery. While these engineers went as salesmen, their work was mainly to educate the engineers and the industrial men of other countries in American methods. They had to show these prospective customers why our way was the cheaper way. They had to prove that the use of our standard machines would produce results more quickly and economically than special machinery. These men worked under great handicaps, but they made good. They demonstrated that it was practicable to sell standard American machinery, instead of merely taking orders for special machines.

How the War has Educated Foreign Buyers

In the last two or three years conditions have changed completely. The world has learned more in that time about American engineering methods than could have been forced upon it in a generation through the most strenuous commercial efforts. Engineers from everywhere know the wonderful results our forces have achieved in building, equipping, and operating ports, railways, highways, and machine shops in France. The world is ready now to adopt American industrial methods. That this change has occurred is demonstrated by the character of the inquiries that are being received by every American manufacturer of engineering machinery who has made any real effort to secure export business. The great bulk of engineers from overseas do not inquire now about the technical details of the machines only; they want to know how the machines are used. They want to know whether the problems that they have to meet can be solved by American methods. The whole industrial world wants to be educated in our way of doing engineering work.

If the opportunity is handled right, no limitations of the trade possibilities thus presented need be considered. The thing is to put the work in the hands of men who are thoroughly schooled in American methods of using American machinery. It goes without saying that these men must have commercial sense. They must know how to deal with other business men; but above all they must have the "know how" of what they are trying to introduce. They must be able to sell ideas, not merely to take orders.

The Engineer Salesman

A few examples may illustrate how engineer salesmen work. These examples also will indicate the type of men required to introduce American engineering methods and to sell standard American machinery. Take the largest American manufacturer of mining machinery; this concern consistently has followed a policy of using engineer salesmen abroad. The company has branch offices or agencies in all the countries in the world where mining and quarrying are done on any considerable scale. In each of these branches or agencies there is one or more engineers who have had considerable experience in American methods of mining and quarrying. These men are actually selling drill holes in the rock and tons of ore in the car, instead of rock drills and compressors. When a new proposition comes up, they help to study the conditions to be met and advise what equipment is best suited to these conditions. In the case of existing works they must go right in and prove how American machinery and American methods will save money as compared with present means.

Here is another case. American sawmill machinery is used extensively in a far eastern country, as a result of the work of a single American engineer salesman. This man knew thoroughly American methods of cutting timber, handling logs, and running sawmills. When he went to that country a few years ago he was totally unfamiliar with the language. He went out and lived among the timber operators where he learned their language, their customs, and their conditions; and then he showed them how American methods could cut more and better lumber at less cost. These American methods required standard American machinery. Scarcely a logging or a sawmill job now comes up in that country without this man being consulted in regard to it. His knowledge of the engineering side of the business, his keen commercial sense, and his willingness to get right out on the firing line, far outweighed his previous lack of knowledge of the language and customs. No commercial salesmen, familiar with the language and the customs of the country, but lacking the engineering knowledge of the trade, could have made good at all in this work. Numerous other examples of the success of American engineer salesmen abroad could be cited.

Wherever you find an American sales engineer, trained for work in the foreign fields, you will find him introducing American methods in the manner that these examples illustrate. The executives who have had experience with men of this caliber are convinced what overseas policy they must follow to get results. The ordinary commercial salesman simply will not do. The engineer salesman, of proper qualifications, is almost assured of success in realizing on the opportunities that are presented in foreign markets to American engineering machinery manufacturers.

Difficulty in Finding Engineer Salesmen of Proper Qualifications

Scarcity of the right kind of men is the one big problem in adopting a sales engineering policy in export marketing. It is comparatively easy to find men who are thoroughly grounded in American methods of using any line of engineering machinery. When these men are sorted on the basis of ability to deal with business men, the percentage of rejections is large; and those who do pass this test are nearly all eliminated when considered as to their commercial sense. This does not necessarily apply to their commercial experience, but rather to their ability to sense a commercial possibility. The few candidates who are left when these simple tests have been applied would nearly all be discarded on account of lack of knowledge of any foreign languages. It frequently is necessary, therefore, to overlook this qualification and to send out to a foreign country a man who must learn the language after he arrives. Any man who goes out thus handicapped is bound to work under great difficulty. Experience gained by a number of American engineering machinery manufacturers has demonstrated, however, that such a handicap is far less serious than a lack of knowledge of American methods of using the machinery to be marketed.

This conclusion is heresy in the minds of most people experienced in regular commercial export trade. Right here it is well to draw a definite line between the marketing abroad of commodities and articles of ordinary commerce and the sale of engineering machinery. Antiquated industrial and engineering methods are much the same the world over. When the operations affected are sufficiently large to justify the use of machinery instead of hand labor, the work is nearly always in charge of men who can understand engineering arguments. These arguments are the same everywhere. It certainly is a handicap not to be able to present them in the language of the men to whom an engineer sales-

[1]Abstract of an address presented before the Technical Publicity Association, November 14, 1918.

man must talk, but it is a far greater handicap not to know what the arguments are.

Methods of Application of Engineer Salesmen

The average American manufacturer wants to know how he can adopt the plan of using American engineer salesmen to sell his products abroad. This has been done in a good many ways, in each of which there have been some successes and some failures. For the large manufacturer, the problem is comparatively simple. He can afford to establish his own branch offices in the most important centers of the world. He can also afford to supply his own trained men to cooperate with agencies in other centers of less importance. The manufacturer having a more limited output has three principal opportunities open to him under present conditions: (1) He can turn his export sales over to one or more general export commission houses with branch offices in the countries in which he desires to operate. (2) He can join with a group of non-competing manufacturers in similar lines, cooperating to reach the foreign markets in which these manufacturers are interested. (3) He can bring together a group of his competitors under the Webb-Pomerene Bill to form an organization that will obtain export business for all of them. The best plan to be adopted by any manufacturer can be determined only after careful study of what he wants to accomplish, the markets to be reached, and his own limitations.

1. Some general export commission merchants have been quite successful in introducing and marketing American engineering machinery abroad. These concerns are of sufficient size to justify them in maintaining engineering sales departments, which, to all intents and purposes, are separate machinery houses utilizing the experience and the facilities of the organizations of which they are a part. Unfortunately the number of general export commission houses so organized is limited. The general export concerns which attempt to market engineering machinery as they do ordinary commodities make some sales; but they cannot, in the nature of things, build any business.

2. Cooperative export engineering sales organizations developed by a group of non-competing manufacturers in allied lines is a comparatively new idea. Such cooperative concerns, properly conceived, organized, and financed, apparently offer the average engineering machinery manufacturer one of his best opportunities to reach the export market. In the first place, such an organization insures each manufacturer of the benefit of thinking of all the manufacturers in the group. This collective thinking eliminates many of the difficulties which individual manufacturers would encounter. This plan permits the group to maintain properly trained engineer salesmen on salary in practically all of the centers of the world where there is an opportunity for the use of the particular general line of machinery involved. This means that each member of the group has good representation in many places, whereas that member could not afford to have a salesman call in many of these places even occasionally.

3. Just how combinations of competitors under the Webb-Pomerene Bill will work in the engineering machinery field remains to be seen; thus far no such combination has been undertaken. In certain lines of commodities and of quite standard products there are undoubtedly advantages to be gained through operation under this bill. The difficulties apparently are such, however, that no group of competing manufacturers of engineering machinery has seen its way clear to attempt to combine in marketing their products outside of the United States.

Whatever plan is adopted by the American engineering machinery manufacturer in his export sales work, he can build a large and permanent market only by introducing American methods of using his machinery. Such introduction can be made properly only by experienced American engineer salesmen and it is to be hoped that American manufacturers thoroughly appreciate this fact.

EXPORT TRADE PROMOTION AND PROTECTION[1]

By B. OLNEY HOUGH, Editor of American Exporter

Whatever else is to be said about the possibilities of after-the-war trade, it seems to me that Anglo-Saxon individualism must continue to be the most potent factor in the development of the two greatest exporting nations in the world. Government encouragement and assistance must be purely incidental. American and British manufacturers and exporters must continue to rely on themselves alone, if they are to continue as the greatest exporters of the world. For from one to five years after the restoration of peace, there will be tremendous demands upon the manufacturing facilities of these two nations, especially in the engineering lines. These demands will probably be far greater than many of us at present imagine.

Personal Element in Foreign Trade

The personal element in foreign trade must be extended in our dealings with foreign markets all around the world. This is the surest means of trade promotion. There can be no question of the great superiority, over every other means, of the factory salesman personally visiting his customers in other countries; but it is a physical impossibility for any salesman to visit every possible foreign market, or even all important markets, and whether or not salesmen are employed, there always remains the positive necessity in foreign countries, as in our own, of advertising.

Advertising in the Export Trade

Advertising may be of various kinds. There is the advertising designed to increase foreign connections, to establish more agencies, distributors and dealers, and to increase the number of consumers. There is the advertising, which is purely along the line of general publicity. There is the local advertising in foreign markets to increase the local trade of the agent, distributor, or dealer. Perhaps this sort of advertising may not be so desirable in the case of steam engines, or electric light or power plants, as it is to the manufacturer of electric household devices, for example, or of electric heaters, cooking devices, fans, etc.

The usual export copy for engineering products is not always what it ought to be. You find a cut of a machine tool or a cut of a dynamo with details of the floor space occupied, the different sizes made, the diameter and revolutions of the pulleys, etc. Rarely do you find an advertisement enumerating the essentially vital points of novelty and superiority in the apparatus advertised. What is there about a machine tool, for example, that is different from, and better than, the competitors'? Does it do more work in eight hours, or better work, and why? Does it require a less skilled attendant? Briefly, what is there to stimulate the interest of the reader of the advertisement, and to influence him to believe that the tool advertised is something he should or must have? It goes without saying that this is the object of all advertising.

Advertising includes more than newspaper, trade paper, or magazine announcements. It should include all propaganda work, catalogues, booklets, envelope stuffers, as well as a service department, including dealer's helps and hints, and assistance to operators—in general, the maintaining of a genuine enthusiasm on the part of buyers and users.

The Advertising Manager as a Salesman

The advertising manager should cooperate more intimately with the export manager in the developing of business through correspondence. The sales manager or any salesman may be expert in the art of salesmanship as exercised in the face-to-face meeting with customers; but comparatively few such salesmen know how to put effectively on paper the sales talk which they habitually use in obtaining orders

[1]Abstract of an address presented before the Technical Publicity Association, November 14, 1918.

by word of mouth. The advertising manager ought to have, or be able to develop with comparative ease, this art of propaganda work through correspondence. Why, therefore, should not the sales manager rely on the close cooperation of the advertising manager in the preparation and conduct of his foreign correspondence? Men always buy more willingly from people they know, and stick to them the longest. No manufacturer or exporter, no export manager or advertising manager, can be acquainted with all of his trade personally; but he may approximate such a personal acquaintance through correspondence, both for the promotion and for the protection of foreign trade.

The question of correspondence with foreign prospects, customers, and friends is the weakest factor in our export work. There is an opportunity for a great improvement in this respect—in the selling of goods on paper and in the promoting of loyalty to goods when they have once been introduced, right down the line to the very mechanics and operators of the machines.

Export Promotion Methods

There is also an opportunity for the promotion of export trade through cooperation with American export houses. In all engineering lines these export concerns, or their branch offices in foreign countries, require cooperation on the part of the manufacturer—and every honest house among them will acknowledge this. They are not, and cannot be, in a position to develop engineering experts. The advice and help of men trained in engineering is invariably required. As a matter of fact, no kind of machine ought ever to be shipped to a foreign market, except standard types, unless a trained mechanic or engineer is sent with it to see that it is properly installed and that local mechanics are taught how to operate it properly. If there is any trade to be developed in a machine or apparatus of any kind in any foreign market, it seems worth sending such an engineer, even if only one machine is shipped, and the cost of so doing appears extravagant. Upon the successful operation of the first machine may depend all future trade in the market in question.

A Case of Losing Touch with the Customer

How necessary the personal element is may be illustrated by the following incident. Some years ago, when the writer was leaving for a trip to Europe, a manufacturer of hay presses asked him to call on a certain customer of his in Europe and find out why his trade had fallen off from a considerable business to almost nothing. In calling on this customer, it was found that he liked the American hay presses, but that farmers in his part of the world wanted to run the hay press in conjunction with the threshing machine instead of separately. German manufacturers who were hustling for business quickly learned of this state of affairs and simply provided an extra pulley for the threshing machine and ran the hay press by a belt from that pulley. The machinery merchant did not care whose goods he sold, whether they were American or German, although he confessed that he did not like the German so well as the American—but the American manufacturer had never been to see him since the first trip when his goods were introduced, and the Germans were giving him something that his trade required. Now, if this personal connection of the American manufacturer had been intimate, even if merely through the right sort of correspondence, the feeling of mutual interest would have been promoted, the loyalty and enthusiasm of the buyer properly developed, and the Germans would never have had an opportunity in that market.

To summarize, know your customers in person whenever you can. When you cannot, know them on paper. Salesmanship on paper is the greatest single element in any export trade promotion. Enthusiasm on the part of your customers, can be created only by the enthusiasm that you take pains to instill. A thorough study of foreign problems is the only road that will lead to a successful foreign trade.

NATIONAL RECONSTRUCTION ACTIVITIES

The War Department has announced that the fundamental policy underlying its plans for industrial demobilization will be to prevent undue disturbance of labor and industrial conditions, and, in order to carry out this policy, Major-General Goethals, Director of Purchase, Storage, and Traffic, has requested the various Governmental bureaus to request the advice and assistance of the War Industries Board in all cases where contracts are affected by the cessation of hostilities. General Goethals has been placed in charge of adjusting cancellations of War Department contracts in accordance with the views of the War Industries Board. Only orders placed since October 1, and those regarding which the contractor himself states in writing that no disturbance of labor would be caused, may be cancelled without reference to General Goethals. Manufacturers are cautioned that no labor should be engaged on present war contracts and no additional subcontracts should be let without the approval of General Goethals. The first cancellations, it is assured, will be of those contracts upon which work has not yet been started, and which provide for the manufacture of war material which will not now be needed by the army or navy. Next in order will be those on which work is now being done, but which it is seen will not be needed. In the case of these cancellations, precautions will be taken to observe care that industrial and labor conditions are disturbed as little as possible. The effect of every cancellation will be studied in advance.

Regulations Relating to Distribution and Prices of Steel

Regulations as to the distribution of steel have already been altered in important particulars and other modifications are to follow. Nothing, however, has as yet been done as to prices. The practice has been to set prices quarterly, and the existing price-list will run through to December 31. However, the War Industries Board will probably make an announcement in the near future, and a reasonable time before the end of the quarter of the year, as to prices after December 31. According to former practice, these prices would be for three months, but the suggestion has been made that the prices in the future might well be set for six months at a time. As to wages in the iron and steel industry, there are two facts: first, that the cost of living has greatly advanced; second, that the labor supply from which the iron and steel business has been recruiting its forces for many years has been greatly reduced, because immigration has been almost entirely shut off. Hence, prices higher than normal are to be expected for some time to come.

Regulations Relating to Export Licenses

The War Trade Board has announced that the regulations heretofore prescribed as to the signing of applications for export licenses, as issued September 10, 1918, have been rescinded. The regulations requiring the filing of "powers of attorney" have also been rescinded. In order to facilitate the work of filing applications for export licenses, the War Trade Board will now accept applications if it shall appear from the application itself that it bears the personal signature, in ink, of the consignor or of some person to whom the consignor has delegated the duty of signing the applications.

Shippers will be held responsible, as heretofore, for all statements made upon applications and for full compliance with all rules and regulations of the War Trade Board, and their attention is called to the following provision contained in the form of export license: "By accepting or acting under this license the person to whom the same is issued warrants the correctness and truthfulness (1) of all answers made and statements contained in the application filed with said Board for this license, and (2) of all information given in response to any further requirements of said Board in connection therewith, which application and information are by reference made parts hereof."

The War Trade Board further announces that, except as hereinafter set forth, all export licenses issued on or after November 15, 1918, and all export licenses which were unexpired on the 15th day of November, 1918, will be valid until used, unless revoked, notwithstanding such licenses are stamped as expiring on November 15, 1918, or subsequently thereto. Collectors of Customs and the Post Office Department have been advised accordingly; and therefore they will accept licenses (excepting those hereinafter set forth) when the expiration date is specified on the license as November 15, 1918, or later. The foregoing rule does not apply to licenses for the exportation of any commodity to Norway, Sweden, Denmark proper, European Holland, Iceland, Faroe Islands, Switzerland, or Greece; and Collectors of Customs and the Post Office Department will not accept licenses for the exportation of any commodity to such countries except in accordance with the regulations with respect to the expiration date of export licenses.

Industrial Leaders Frown on the "War-after-the-war" Idea

The opinions of the great leaders in the industrial fields in the United States all appear to agree upon the point that there should be no preparation for an economic war to follow the war that is now ended. Germany will be expected to pay for the destruction wrought in the countries her armies have invaded and laid waste, and in order to be able to pay, she must have an opportunity to manufacture. It has been pointed out that we must either follow that policy, or the policy of entirely ostracizing Germany industrially; but, in the latter case, we must be satisfied with much smaller indemnities for the destruction caused by her in the war, because, without any foreign business, she would not have the ability to pay her great debt to the allied nations. James A. Farrell, president of the United States Steel Corporation and chairman of the Foreign Trade Council, is one of the men who believes that the peace conditions should be such that there will be no need for economic warfare.

Crippled Soldiers being taught to take their Place in Skilled Occupations in the Industries

Shipbuilding will Continue at High Speed

Ships will constitute the first factor in our great task of reconstruction and in the development of our foreign commerce after the restoration of peace. American ships will be the essential agency through which the nation will be able to maintain the place in foreign trade relations that it justly has acquired through the aid it has rendered in the successful termination of the war. The completion of the program of the Shipping Board will result in a merchant marine roughly estimated at 14,000,000 tons. Such a merchant marine, it has been pointed out, would be ample to meet the needs of the American foreign trade. More than 385,000 employes are now at work in American shipyards; two years ago this number was less than 50,000. The existance of so large a body of labor trained in ship construction constitutes an important asset in American industrial development.

Announcement has been made that American-owned vessels requisitioned by the Shipping Board will not be turned back to their private owners until after the food emergency in Europe has passed away. The Shipping Board and the Secretary of Commerce, however, have been petitioned by merchants and manufacturers to make some of the tonnage available for exports, so that American manufacturers may enter the markets of the world rapidly and on even terms with the manufacturers of other countries. Lack of tonnage here would handicap American manufacturers as compared with those of Great Britain and some of the neutral nations in Europe whose shipping facilities would be available for export trade.

Expansion of Department of Commerce Advocated

The expansion of the Department of Commerce was advocated by Burwell S. Cutler, chief of the Bureau of Foreign and Domestic Commerce of the Department of Commerce, Washington, D. C., before the convention of the American Manufacturers Export Association recently held in New York City. At the present time, there are only eleven American commercial attaches, while the United Kingdom has twenty-seven, and Canada has twenty-three, under the name of resident trade commissioners. Instead of having only thirty traveling agents covering the entire world, as is at present the case, it is advocated that there be thirty of these agents for Europe alone and an equal number in the Far East and South America. Higher salaries are also necessary for the men who do important trade research work. Salaries of from $3000 to $4000 a year are allowed to the regular Government commissions and to some of the war boards for assistance of this kind, whereas the Department of Commerce has been restricted to salaries of about $1800 per year. As a result, the bulk of this class of work falls upon the division administrators, who should be left free to handle larger problems.

Credit Facilities for Buyers of Allied Nations

The banking interests of the United States are taking steps toward financing the reconstruction operations in France, Belgium, and Italy at the end of the war. This work will be done in cooperation with the State Department and Congress, and in this way credit facilities will be established for the allied nations in the United States. The bankers still are working considerably in the dark, as it is not yet definitely known whether the United States Government will undertake part of the necessary financing of the reconstruction work in the allied countries in a somewhat similar manner as that in which the financing during the war period has been carried on. The banking interests are contemplating large issues of foreign securities in this country in case the way is open for them to participate on a large scale in the international financial operations abroad.

* * *

PLANS FOR EDUCATING THE RETURNING SOLDIERS FOR INDUSTRIAL WORK

The United States Department of Labor is endeavoring to develop a service which will make it possible for every soldier upon his return to the United States to enter civil life as a skilled workman, able to maintain himself on par with the best of his fellow-workers. Steps have been taken to teach vocations to the returning soldiers and to provide opportunities for them, both as regards education and as regards employment in business or in the industries. Those who wish to devote themselves to agriculture will also be

given aid. An information service, known as the Information and Education Service of the Department of Labor has been created which will gather information on these subjects and distribute it among the returning soldiers so that they may be placed in touch with opportunities open to them. The Department of Labor requests manufacturers who wish to aid in this important work to communicate with the inquiry office of the Department of Labor, 1706 G St., N. W., Washington, D. C.

The American Red Cross maintains, at 311 Fourth Avenue, New York City, the Red Cross Institute for Crippled and Disabled Men, headed by Dr. Douglas C. McMurtrie. Six courses have been instituted thus far: The manufacture of artificial limbs; oxy-acetylene welding; mechanical drafting; typesetting; motion picture machine operating; and jewelry work. These trades, it is deemed, are especially fitted for disabled men. Briefly, the plan of the United States Government working in conjunction with the Red Cross for the rehabilitation and vocational training of men crippled in the war is as follows: In the hospitals in France, convalescent men are shown moving pictures of successful crippled men at work. The actual work of training, however, does not begin until the soldier has returned to the United States. Here, however, the process of shifting him to normal life and responsibilities begins upon his arrival in the great military hospitals. The preliminary work is done in the wards, while later the men are sent from the wards to well-equipped new buildings provided with work-shops where there are classes in mechanics, short-hand, typewriting, rug weaving, artificial limb making, carpentry, and other trades. Later, the work is taken in hand by the Federal Board of Vocational Education. A complete program has not yet been developed, but the work is well under way.

However, the details of the program are not nearly as important as is the attitude taken by the Government with regard to the disabled men. The responsibilities of the Government do not cease by merely pensioning the man; he will, in addition, be fitted to take perhaps even a better place in the industrial community than he occupied before his injury. The Government will continue to pay generous pensions to all disabled soldiers and sailors, and these pensions will be granted regardless of a man's earning capacity that he develops in spite of his infirmity. The manufacturers of the country, of course, will cooperate in this great work and thereby render the efforts of the Government and the Red Cross successful.

* * *

ORGANIZATION FOR RECONSTRUCTION IN GREAT BRITAIN

Great Britain, which has dealt most extensively with the problem of reconstruction, passed three distinct stages in the arrangements made by its government for dealing with reconstruction problems. As outlined in an article by S. Zimand, in *The Public*, November 16, the subject of reconstruction in Great Britain was at first referred to a committee consisting exclusively of Ministers of the Crown who were members of the Cabinet. After the present government took office it became clear that those who are specifically entrusted with the consideration of reconstruction problems must reduce to a minimum any duties in the nature of current administration which may tend to fall upon them. In March, 1917, the government recognized this situation and created a new body for reconstruction purposes. This body had as chairman the Prime Minister, and the remaining fourteen members of the committee were selected on the principle of entrusting the work to a body possessed of specialized knowledge. They include members of Parliament who have shown a special concern with some of the problems under review as well as representatives of labor. This committee made inquiries into reconstruction problems, initiated or caused to be initiated other investigations and made it their business to see that no part of the reconstruction work should be neglected for want of inquiry and attention.

In July, 1917, the English Government decided that the problems of reconstruction had passed into a third stage and established a Ministry of Reconstruction to continue for the duration of the war and for a period of two years, or less, after its conclusion. The functions of the Minister of Reconstruction who assumed office in August, 1917, are defined as follows:

"To consider and advise upon the problems which may arise out of the war and may have to be dealt with upon its termination, and for the purposes aforesaid to institute and conduct such inquiries, prepare such schemes and make such recommendations as he thinks fit, and the Minister of Reconstruction shall, for the purposes aforesaid, have such powers and duties of any Government Department or authority, which have been conferred by or under any statute, as his Majesty may by order in council authorize the minister to exercise or perform concurrently with, or in consultation with, the Government Department or authority concerned."

The Minister of Reconstruction is kept informed of all proposals for dealing with post-war problems which are under consideration by any government department or committee or brought forward by responsible bodies or persons, and ultimately submits to Parliament a policy of reconstruction in all its branches. The department has been divided into branches dealing respectively with commerce and production, including the supply of materials; with finance, shipping and common services; with labor and industrial organization; with rural development; with the machinery of government, central and local; health and education; and with housing and internal transportation.

The Minister of Reconstruction has created an Advisory Council to assist him in considering the various proposals which come before him. The council consists of representatives of all the leading interests concerned in reconstruction and is so organized that in each section all the principal interests represented on the council should find a place. This is how Great Britain is trying to solve the great problem of reconstruction. The more the reconstruction work progresses in this country, the more the necessity of a systematized service dealing with the reconstruction problems will be felt. The Departments of the Interior, and Commerce and Labor will have to be relieved from the work of guiding the reconstruction work.

Cooperation with the different departments will always be necessary, but the problem of reconstruction must be intrusted to the hands of a general committee to deal especially with the outlining of a reconstruction policy.

* * *

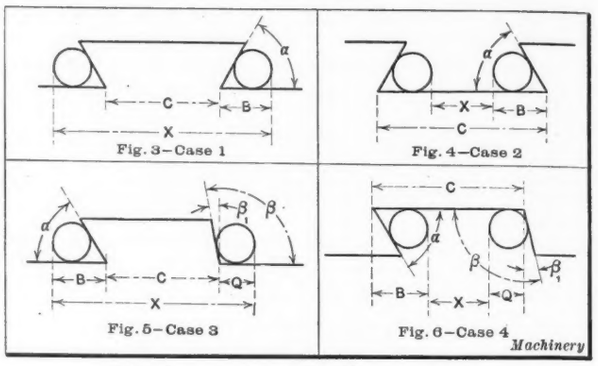
Figures compiled by Frank J. Katz of the United States Geological Survey, Department of the Interior, and obtained in cooperation with the Canadian Department of Mines, show a decided increase in the output of artificial abrasives during the first half of the year 1918, as compared with the first half of 1917. There was little change in the output of corundum, however, and a decrease in the output of emery. The combined output of emery and corundum in the United States and Canada for the first half of the year 1918 was 5455 short tons; the amount sold, shipped, or manufactured into abrasive articles, 4500 short tons; and the amount remaining as stock at the expiration of that period, 1500 short tons. The artificial carbide abrasive output for the same period of time including carborundum, crystolon and carbolon, for the two countries, was 6583 short tons of crude material; 5633 short tons consumed in the sale or used for the manufacture of abrasive materials; and 2840 short tons remaining as stock. The aluminum oxide abrasives output including alundum, aloxite, exolon, lionite, and natite was, for the first six months of the year 1918, 28,341 short tons; sold or used in the manufacture of abrasive materials, 28,161 short tons; and 26,221 short tons remaining in stock.

ACCURATE MEASUREMENT OF DOVETAIL WAYS

BY V. BROCKBANK[1]

Assuming that the angles of dovetail ways have been correctly planed, the most accurate method of checking their width and the one most commonly applied is to lay a standard round plug in each way and take the measurement between or over them with a vernier caliper. Much tedious fitting can be avoided by planing closely to size, allowing but 0.002 or 0.003 inch for scraping. If the proper means are provided for accurate measurement, this can be easily done.

Used in conjunction with standard plugs which may be made in pairs, the accompanying table will be found convenient for determining the correct vernier reading. The figures given in the table are derived from the following formulas:



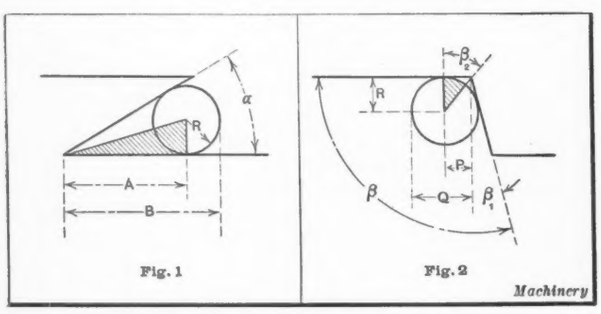
Figs. 3 to 6. Four Applications of Formulas

TABLE FOR USE IN MEASURING DOVETAILS

Diameter of Plug, Inch	Angle α Degrees	Distance A, Inches	Distance B, Inches	Angle β1 Degrees	Angle β Degrees	Distance P, Inch	Distance Q, Inch
3/8	40	0.51516	0.70266				
	45	0.45266	0.64016	10	100	0.15733	0.34483
	50	0.40209	0.58959	12	102	0.15183	0.33933
	55	0.36019	0.54769	15	105	0.14387	0.33137
	60	0.32475	0.51225				
1/2	40	0.68688	0.93688				
	45	0.60355	0.85355	10	100	0.20978	0.45978
	50	0.53613	0.78613	12	102	0.20245	0.45245
	55	0.48025	0.73025	15	105	0.19183	0.44183
	60	0.43300	0.68300				
3/4	40	1.03031	1.40531				
	45	0.90533	1.28033	10	100	0.31466	0.68966
	50	0.80419	1.17919	12	102	0.30367	0.67867
	55	0.72038	1.09538	15	105	0.28775	0.66275
	60	0.64950	1.02450				
1	40	1.37375	1.87375				
	45	1.20710	1.70710	10	100	0.41955	0.91955
	50	1.07225	1.57225	12	102	0.40489	0.90489
	55	0.96050	1.46050	15	105	0.38367	0.88367
	60	0.86600	1.36600				
1¼	40	1.71719	2.34219				
	45	1.50888	2.13388	10	100	0.52444	1.14944
	50	1.34031	1.96531	12	102	0.50611	1.13111
	55	1.20063	1.82563	15	105	0.47958	1.10458
	60	1.08250	1.70750				
1½	40	2.06063	2.81063				
	45	1.81065	2.56065	10	100	0.62933	1.37933
	50	1.60838	2.35838	12	102	0.60734	1.35734
	55	1.44075	2.19075	15	105	0.57550	1.32550
	60	1.29900	2.04900				

Machinery

[1]Address: Superior Machine & Engineering Co., Detroit, Mich.



Figs. 1 and 2. Diagrams for deriving Formulas

In Fig. 1,

$$A = \cot\frac{\alpha}{2} - R$$

$$B = A + R \qquad (1)$$

where α = an angle less than 90 degrees, and

R = radius of plug.

In Fig. 2,

$$\beta_2 = 90 \text{ degrees} - \frac{90 \text{ deg.} + \beta_1}{2}$$

$$P = R \tan\left(90 \text{ degrees} - \frac{\beta}{2}\right)$$

$$Q = P + R \qquad (2)$$

where β = an angle greater than 90 degrees, and

R = radius of plug.

In the practical application of these formulas, there are four cases to be considered, as in the following notation:

Case 1, Fig. 3.—Male form, where both angles are less than 90 degrees. Distance C and angle α are given; then insert the value of B from Formula (1) to obtain the value of X:

$$X = C + 2B$$

Case 2, Fig. 4.—Female form, where both angles are less than 90 degrees. Distance C and angle α are given; then

$$X = C - 2B$$

Case 3, Fig. 5.—Male form, where one angle is less and one angle greater than 90 degrees. Distance C and angles α and β are given; then insert the values of B and Q from Formulas (1) and (2) to obtain the value of X:

$$X = C + B + Q$$

Case 4, Fig. 6.—Female form, where one angle is less and one angle greater than 90 degrees. Distance C and angles α and β are given; then

$$X = C - (B + Q)$$

* * *

The best temperature at which to quench carbon steel for the purpose of hardening being at the non-magnetic point, an instrument for determining this point has been applied to electric heat-treating furnaces by a British company, according to the *Scientific American*. The furnace chamber consists of an inner pot containing a mixture of salts having comparatively low melting and high vaporizing points. The pot is wound with a heating coil, and is provided with a heat-resisting lagging. An insulated copper coil is wound around the outside case of the furnace, the ends of which are connected with a galvanometer. A current of electricity passing through the heating coil will quickly heat the furnace, melt the salt mixture, and magnetize any steel article that is within the pot. When the steel has been heated to the non-magnetic point, the deflection of the needle indicates that the desired temperature has been attained.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

IN THIS NUMBER

Knapp Thread Inspection Equipment. Arthur Knapp Engineering Corporation, 101 Park Ave., New York City. .. 357
Heald No. 65 Cylinder Grinder. Heald Machine Co., Worcester, Mass. 360
Kent "Keg-konveyor." Kent Machine Co., Kent, Ohio 362
American Pneumatic Collet Chuck. American Pneumatic Chuck Co., 9 S. Clinton St., Chicago, Ill. 363
Haynes "Tip-it" Compound for Welding Stellite to Steel. Haynes Stellite Co., Kokomo, Ind. 363
Improved Arc Welding Tool. Arc Welding Machine Co., Inc., 220 W. 42nd St., New York City 364
Burke Vertical Milling Machine. Burke Machine Tool Co., Conneaut, Ohio. 364
Reynolds Traveling Radial Screwdriving Machine. Reynolds Machine Co., Massillon, Ohio. 364
General Electric Overload Protective Plugs. General Electric Co., Schenectady, N. Y. 365
Fischer Profile Grinding Machine. Fischer Machine Co., 310 N. 11th St., Philadelphia, Pa. 366
Oliver Shell Lathes. Oliver Mch. Co., Grand Rapids, Mich.... 367
Gustin-Bacon Reversible Driving Chuck. Gustin-Bacon Mfg. Co., 1416 W. 12th St., Kansas City, Mo. 367
Beach Lapping Machine. Beach Mfg. Co., Boston, Mass. 367
U. S. Electrical Bench Grinding Machine. U. S. Electrical Mfg. Co., 459 E. Third St., Los Angeles, Cal. 368
Hanson Friction Clutch. Hanson Clutch & Machinery Co., Tiffin, Ohio 368
Improvements in Bickett Planer. Bickett Machine & Mfg. Co., Cincinnati, Ohio 368
Universal Drafting Pen. Universal Drafting Pen Co., Inc., 27 Cannon St., Bridgeport, Conn. 369
Red-E High-speed Cutters with Carbon Shanks. Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn. 369
Nivin Metal Parts Washing Machine. Nivin Mfg. Co., Inc., 840 Larrabee St., Chicago, Ill. 370
Chicago Pneumatic "Little Giant" Corner Drills. Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill. 370
Spafford Turret Drill Head. Spafford Tool Works, 10 Hoadley Place, Hartford, Conn. 371

KNAPP THREAD INSPECTION EQUIPMENT

To provide for attaining the utmost precision in testing the thread form, the lead, and the pitch diameter of master thread gages, the Arthur Knapp Engineering Corporation is manufacturing the line of machines which are illustrated and described in this article. These equipments are of the type used in the Gage Division of the Bureau of Standards, Washington, D. C., and they are manufactured by the above company according to designs developed by the Bureau of Standards and by the National Physical Laboratory of England.

IN order to provide for determining the accuracy of various types of master gages which are used as reference standards in checking gages used for measuring the dimensions of interchangeable parts of manufactured products, the Bureau of Standards, Washington, D. C., has established what is known as the "Gage Section." The equipment with which it is furnished includes complete facilities for use in determining with absolute accuracy the shape or thread angle of thread gages, their pitch diameter and the lead of their thread. Special equipments were developed for these purposes and manufacturers desiring to have their master thread gages tested can send them to Washington for that purpose. The methods used by the Bureau of Standards for making these tests depend for their accuracy upon fundamental scientific principles, the apparatus used consisting of a source of white light and means of transmitting and reflecting this light through suitable prisms and from suitable mirrors to give the desired results. Until recently, such apparatus was not available to the manufacturer who had sufficient work to justify investment in equipment of this kind, but the Arthur Knapp Engineering Corporation, 101 Park Ave., New York City, is now making similar equipments to those used by the Bureau of Standards so that they can be purchased for use in the shops of industrial corporations.

Thread Angle Projection Apparatus

In Fig. 1 there is shown the apparatus used for measuring the thread angle. This equipment works on the projection principle, that is to say, a magnified image of the thread is projected onto a suitable stage, and its form is measured by comparison with a master gage or templet of standard form. The apparatus is of the type designed by the Bureau of Standards, Washington, D. C. A feature of the design is that all adjustments of the lantern, gage-holder, and bevel protractor which supports the master templet are within easy reach of one operator. Referring to Fig. 1, the source of light for the projection apparatus consists of an arc lamp contained in the lantern *L*, an arc lamp being used for this purpose because it is the nearest practical approximation of a perfectly white light. Rays of light from the arc pass through a condensing lens *A* and are then projected onto the thread of the gage which is to be measured. In preparing to use this apparatus, two preliminary adjustments must be made, namely the thread gage must be set so that the side on which the thread is to be projected is located opposite the center of lens *B* and the lantern bracket must be swung around its pivotal support

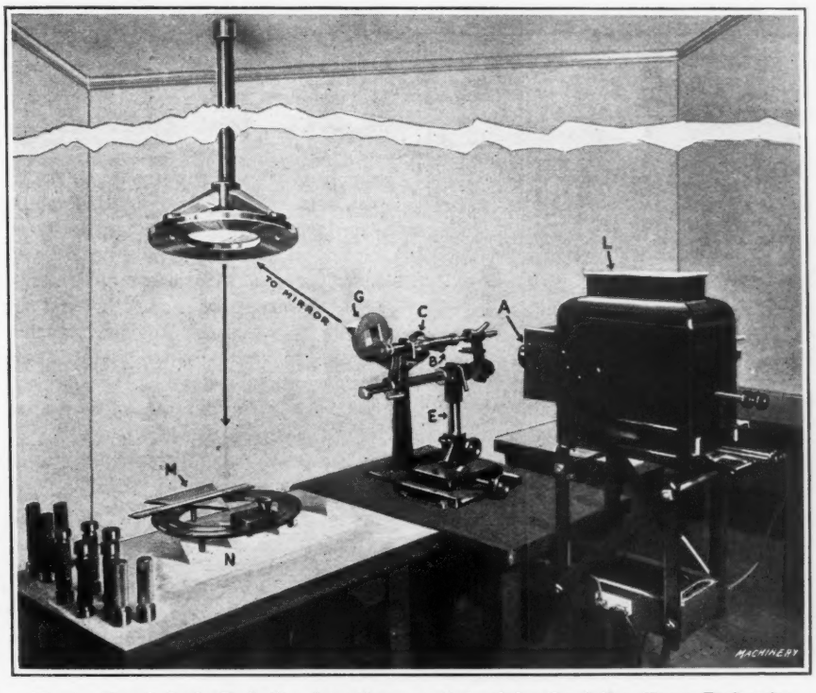


Fig. 1. Thread Angle Projection Apparatus manufactured by the Arthur Knapp Engineering Corporation. This Apparatus was designed by the Bureau of Standards

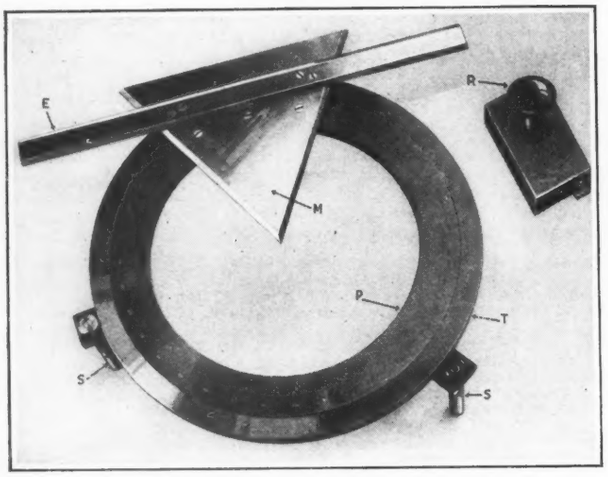


Fig. 2. Vernier Bevel Protractor which supports the Templet with which the Shape of the Image of the Thread is compared

so that the rays of light pass over the gage in a direction tangent to the helix of the thread. After passing the thread gage, the light rays go through projecting lenses *B* and *C* and then through the prism *G* which deflects the light up to the surface of a mirror, as indicated by the arrow.

Care is taken to so adjust the angles of prism *G* and of the mirror that the light rays projected from the surface of the mirror will fall upon the stage *N* in exactly a perpendicular direction. This is important because if the rays did not fall perpendicular there would be danger of inaccuracy in comparing the image of the threads thrown on stage *N* with the form of master templet *M* with which the form of the thread is compared. This master templet has an included angle of 60 degrees so that it may be used direct in checking the accuracy of form of U. S. standard and other 60-degree threads. Where it is desired to check an Acme thread or any other thread than one with a 60-degree included angle, this can still be done with templet *M*. The method of procedure is to first align one side of the templet against one side of the thread image on the stage and then note the reading of the vernier swivel on which the templet is supported. After this reading has been taken the vernier is swung around to bring the opposite side of templet *M* into alignment with the other side of the image of the thread. A second reading of the vernier is then taken, and from the difference of readings, bearing in mind the fact that the templet has a 60-degree included angle, the accuracy of the thread may be determined. Equipments of this kind are made to provide for obtaining a magnification of either 44, 65, or 115 times actual size between the work and the face of the mirror; then by regulating the distance between the mirror and the stage *N* upon which the image is projected, a further degree of magnification can be obtained. The latter result must be calculated for the distance from the stage to the face of the projecting mirror. Tested under such conditions by a method where the personal equation is eliminated, it is obvious that extremely accurate results can be obtained.

So far, the discussion of the use of this apparatus has been based upon its application for testing male thread gages. The same equipment may be employed, however, for testing the accuracy of the thread form of female gages. This result is accomplished by the use of a special core check composition with a known coefficient of contraction and expansion. With this composition a cast is made of a section of the internal thread and then after the cast has been hardened, the accuracy of the thread form of this cast is determined by setting it up on a special support on the gage-holder and proceeding in exactly the same way as in testing the accuracy of a male thread gage. This projection apparatus is also adapted for accurately determining the perfection of thread form of such products as taps and threading dies. It may also be used for testing the accuracy of master templets, etc.

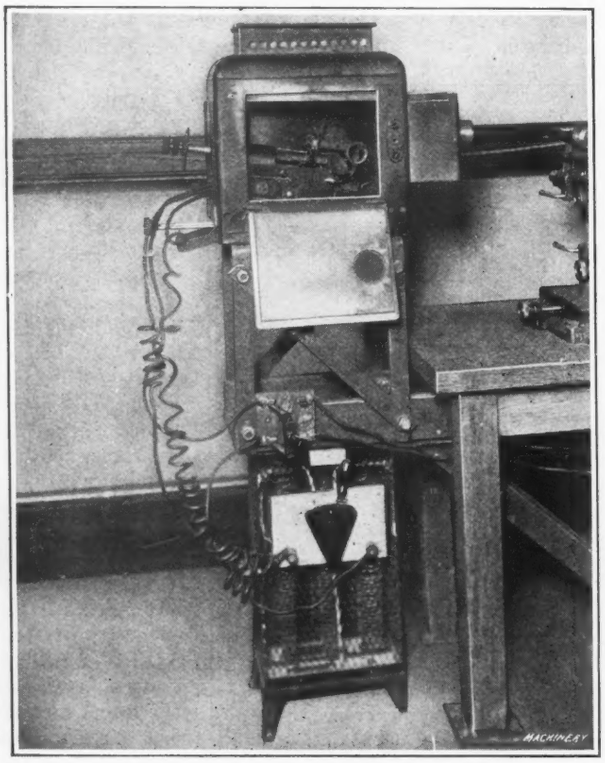


Fig. 3. Lantern containing Electric Arc which is used as the Source of Light for the Projection Apparatus

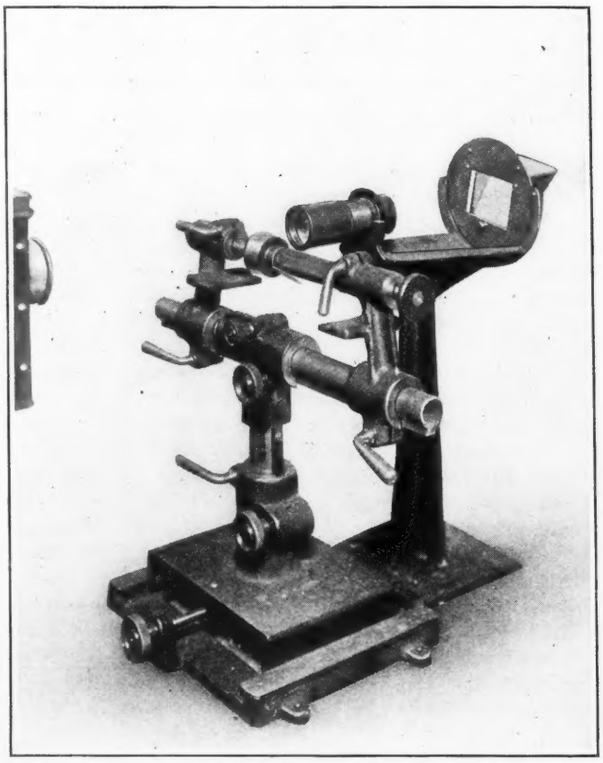


Fig. 4. Close View of Gage-holder, Projection Lenses and Prism for deflecting Light to Mirror

Thread Lead Testing Apparatus

For use in testing the accuracy of the lead of thread gages, the Arthur Knapp Engineering Corporation is making an apparatus illustrated in Figs. 5 and 6. Its construction is based upon designs furnished to the Bureau of Standards, Washington, D. C., by the National Physical Laboratory of England. The illustrations show machines set up for testing a plug thread gage and a ring thread gage, respectively.

In addition to its application for testing the lead of thread gages, this apparatus may be used to advantage in checking the lead of taps, hobs, threading dies and other work of a similar nature, where accuracy of the lead is important. It will be seen that thread gage *X* which is to be tested, is supported between centers carried by a fixed frame *L*, these centers being adjustable to carry thread gages of different lengths. A stylus *A* enters the thread groove, this stylus being carried by a spring support secured to carriage *T* which is free to move longitudinally. When such a movement of the carriage occurs, the stylus swings on its spring support about a fulcrum at the point of the stylus which is in contact with the thread groove. At its rear end, stylus *A* carries a small projection lens *D* through which light is transmitted from a straight line filament *F*. The image of this incandescent filament passes through lens *D* and then by means of two suitable prisms located beneath the table, this image is projected up onto ground glass *G*. There is a line scribed on this ground glass with which the image of the filament may be brought into coincidence by moving carriage *T*.

Mounted at the right-hand end of carriage *T* there is a micrometer head which reads to 0.0001 inch and carriage *T*

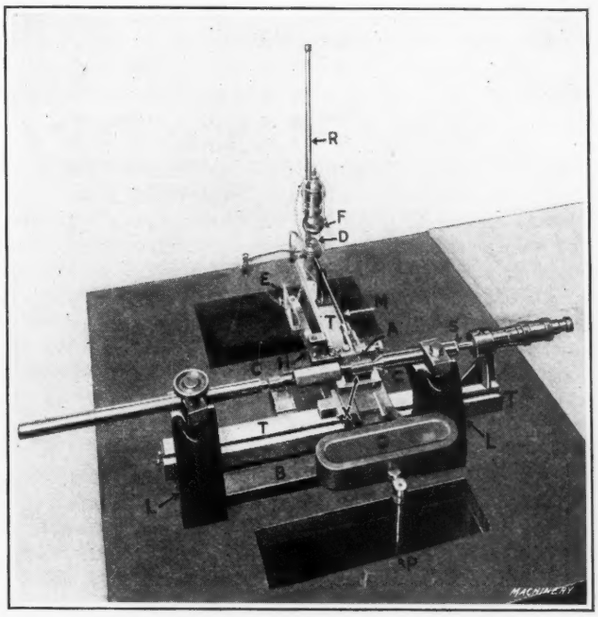


Fig. 5. Thread Lead Testing Apparatus manufactured by the Arthur Knapp Engineering Corporation. This Apparatus is made according to Designs furnished to the Bureau of Standards by the National Physical Laboratory of England

is controlled by a counterweight so that the micrometer spindle is always held in contact with an accurately ground ball *S* at the rear end of the right-hand center. In testing the accuracy of lead of a thread gage with this apparatus, first set the gage up between centers and then enter the stylus point into a thread groove, after which the image of the incandescent filament is brought into coincidence with the line scribed on ground glass *G*. When this result has been accomplished, the reading of the micrometer head is noted, after which the stylus point is withdrawn from the thread and placed in either the next thread groove or any known number of threads from the one in which the stylus was originally located. Before this change can be made, the micrometer head must be turned back so that the spindle is sufficiently released from the ball *S* to allow the required travel of carriage *T*. After setting the stylus in the required thread groove, the micrometer spindle is turned up into contact with ball *S*, and then by carefully turning the micrometer, a sufficient movement of carriage *T* will be accomplished to bring the image of the incandescent filament back into coincidence with the line on ground glass *G*. If the lead of the thread is accurate, the difference in the micrometer readings between the first and second settings

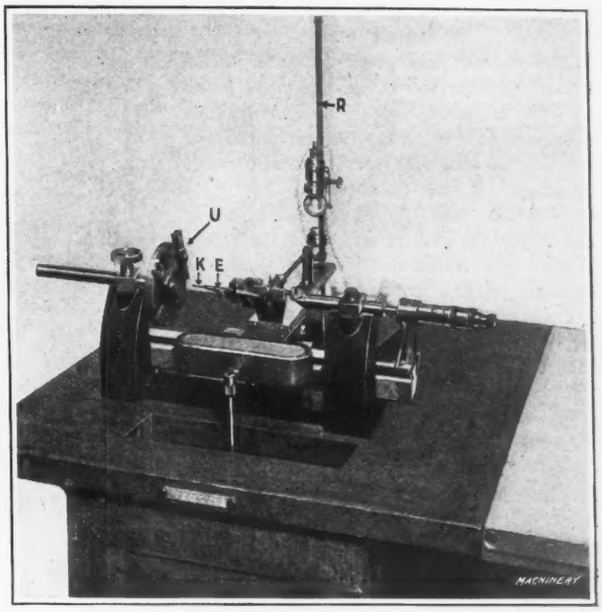


Fig. 6. In Fig. 5 the Thread Lead Testing Apparatus is shown set up for checking the Accuracy of a Male Thread Gage. This Illustration shows the Attachment used for measuring the Lead of a Female Thread Gage

will be equal to either the lead of the thread or some multiple of the lead, according to whether the stylus was placed in the next thread groove to the one originally occupied or several threads farther along the gage. If there is an inaccuracy of lead this will, of course, be determined by subtracting the difference of the micrometer readings.

In using this apparatus for measuring the lead of ring gages an attachment has to be used which provides for reaching into the interior of the gage. The apparatus for this purpose is shown in Fig. 6 and consists of a stylus *E* which has a bent point *K* which will enter the thread groove. The ring gage is clamped to a faceplate by means of straps *U*. It will be seen that stylus *E* is pivoted and connected at its right-hand end to the end of a rod carrying the projection lens through which light from the incandescent lamp is transmitted. Aside from the special means of adapting the apparatus for testing the lead of internal threads, the method of procedure is exactly the same as that described for a plug gage. For testing both internal and external thread gages, the ratio of magnification of the error is 350 to 1 (as shown by the failure of the image from filament *F* to coincide with the line on ground glass *G*), so that it will be apparent that this machine may be used with a very high degree of precision.

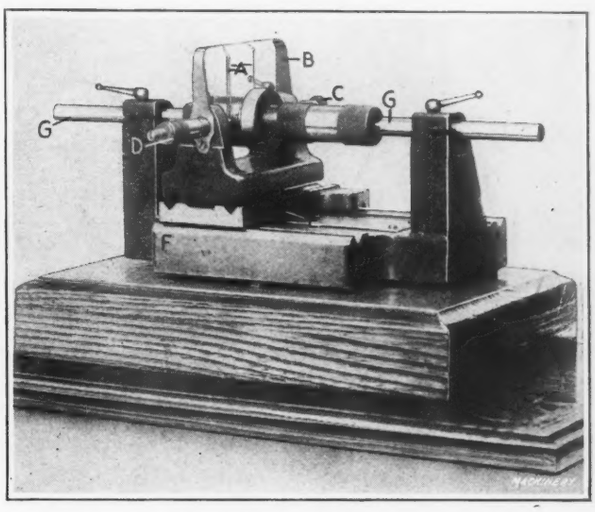


Fig. 7. Thread Pitch Diameter Measuring Apparatus manufactured by the Arthur Knapp Engineering Corporation according to Designs of the National Physical Laboratory of England

Apparatus for Measuring Pitch Diameter of Thread Gages

The thread gage pitch diameter measuring machine shown in Fig. 7 is made by the Arthur Knapp Engineering Corporation according to designs developed by the National Physical Laboratory of England. It will be apparent from this illustration that the apparatus employs the three-wire system and the claim made is that exceptional facility is afforded the operator of the machine in carrying on his work. It will be seen that the three wires *A* are supported by a bridge *B* so that they are conveniently located in relation to the gage. This is a far better method than employing rubber bands to hold the wires on the work, as the tension of the bands bows the wires and is likely to cause inaccurate results to be secured. At one end of bridge *B* it will be seen that there is a stop *C* which is adjustable for different sizes of thread gages which may be tested; and at the opposite end of the bridge there is a micrometer head *D*, which is used in making the measurement over the wires. The entire bridge and other parts of the mechanism are carried on a cross-slide *E*, which is supported by two balls in one of the V-ways and one ball in the third way. This gives a free transverse movement so that the stop *C* and micrometer spindle *D* can instantly center themselves in relation to the thread gage and wires. It will also be seen that carriage *E* is mounted on a longitudinal slide *F* so that the micrometer and wires may be moved along to provide for taking measurements at different points on the thread gage. It will, of course, be evident that the gage is supported on centers *G* and that these are furnished with means of adjustment to provide for holding thread gages of various lengths.

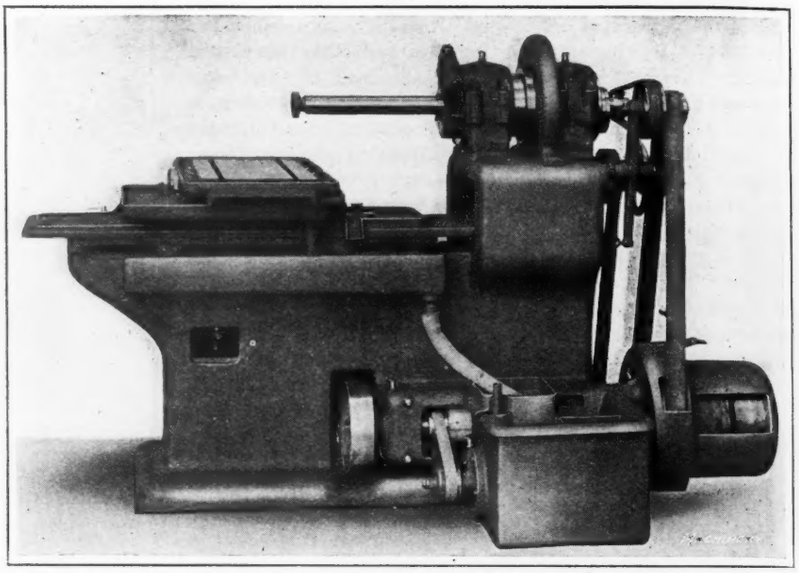


Fig. 2. Rear View of Heald No. 65 Cylinder Grinding Machine

HEALD NO. 65 CYLINDER GRINDER

The Heald Machine Co., Worcester, Mass., is now manufacturing a cylinder grinder (No. 65) which differs considerably in its general design from the preceding or original machine (No. 60). A glance at the accompanying illustrations will reveal one of the important improvements in the design. A solid bed supports both the eccentric grinding head and the work-table, instead of mounting the latter upon a knee having vertical adjustment on the face of the column as on the No. 60 machine. The principal object of this change was to secure a more rigid machine for supporting heavy castings (such as the four- and six-cylinder blocks) and at the same time have as much vertical adjustment as is actually needed in general manufacturing practice. The fact is that in a large percentage of the plants using cylinder grinders, the work-table is not adjusted vertically in operating the machine, except when a very slight vertical movement is necessary for truing up a bore which has been machined a little high or low. The large vertical adjustment on the older machine is not necessary for work of the class mentioned, although it is convenient when the machine is used in repair shops or wherever cylinder sizes are liable to vary considerably. The work-table of the new machine has a vertical adjustment of ⅛ inch to allow for whatever vertical changes may be needed when grinding castings containing more than one bore. The work-holding fixture for the new machine can be easily arranged to hold the cylinder at the required height; and then this adjustment is utilized to compensate for any slight errors in a vertical direction which might exist in the bored cylinder casting.

The vertical adjustment of ⅛ inch is secured by means of an inclined slide *P* (See Fig. 5) located between the main table and the cross-slide table. As this intermediate slide is adjusted in a direction parallel to the main table, it moves either up or down the inclined ways on the main table, thus raising or lowering the cross-slide table and work. In this way an adjustment is obtained which is sufficient to take care of all vertical errors that might exist in the different bores in a cylinder casting. The adjustment of the intermediate slide is affected by turning shaft *O* with a hand crank (see Fig. 1). This shaft is connected through bevel gearing with a screw *R* (Fig. 5) which passes through a nut attached to the intermediate slide.

The method of arranging or supporting the dogs for controlling the travel of the table is a very simple but interesting and ingenious feature of the machine. By referring to Fig. 1 it will be seen that these dogs are not attached to the main table in the usual manner, but are carried by a dog-bar which is supported by the intermediate slide which provides the vertical adjustment. The advantage of this construction is that the travel of the grinding wheel relative to the work is

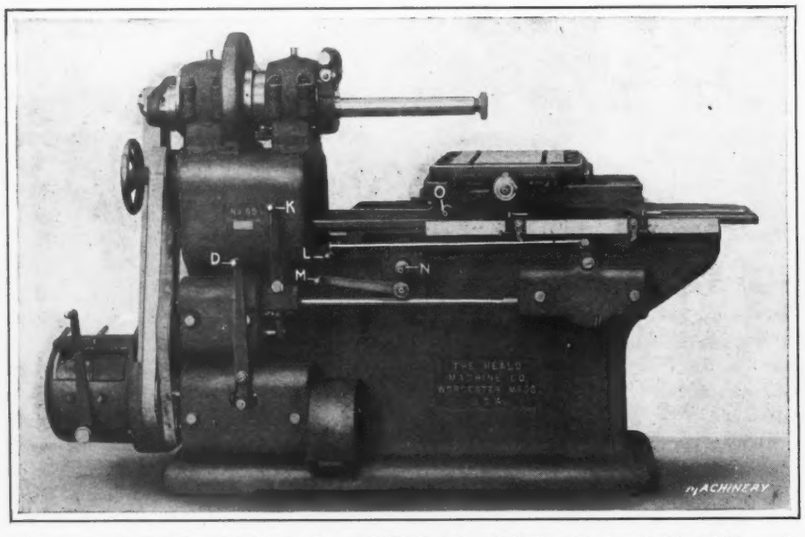


Fig. 1. Heald Cylinder Grinder having a Solid Bed for Grinding Head and Work-table, and a Self-contained Drive

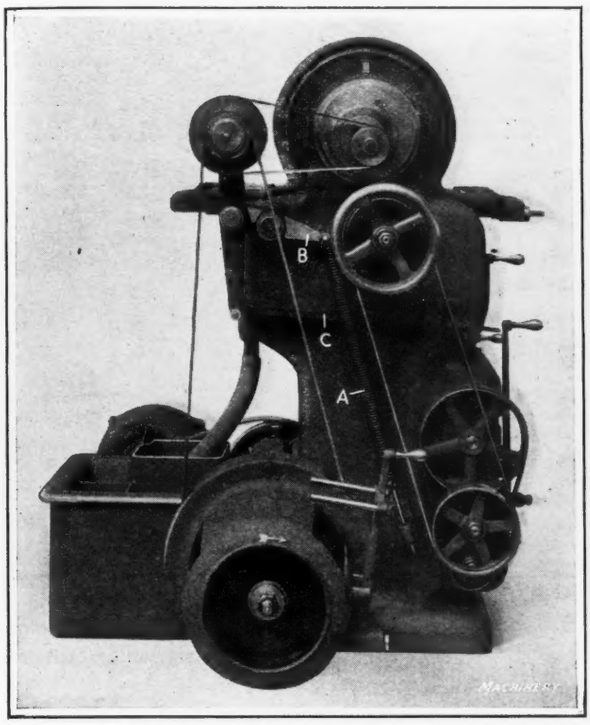


Fig. 3. End View of Cylinder Grinder showing Drive to Grinding Spindle

not changed by any adjustments which may be made for raising or lowering the work. For instance, if the dogs are adjusted to reverse the travel when the wheel is in the correct position relative to the work, these same points of reversal between the wheel and the work will be maintained, even though the intermediate slide may be adjusted. This is due to the fact that as the intermediate slide and work are moved in one direction or the other, the dogs also move a corresponding amount, since they are mounted upon a bar attached to the intermediate slide.

The driving mechanism is another interesting feature of this machine and differs from the arrangement on the No. 60 design. The main driving shaft is mounted at the rear of the machine near the base (see Fig. 2) and is driven directly either from the main lineshaft or from a motor. The machine shown in the illustration is arranged for a lineshaft drive, tight and loose pulleys being provided so that a countershaft or overhead works is not required. In the case of a motor drive, a single belt pulley could be employed. The grinding spindle is driven from the main driving shaft through a flexible idler, one belt connecting with the idler and another belt transmitting motion to the grinding spindle. The tension of these belts is maintained automatically by an ingenious arrangement which may be seen by referring to the end view, Fig. 3. The tension of the belt leading from the main driving shaft is controlled by spring *A*, which connects with lever *B* which, being pivoted in the center, carries the idler pulley upward and maintains whatever tension is required. The lever which carries the idler is also connected at its lower end with spring *C*, which tends to carry the idler backward, thus tensioning the belt leading to the grinding spindle. By means of screws and thumb nuts, the tension on the springs may be varied as required. The speed of the wheel-spindle is changed to suit different diameters of grinding wheels by means of interchangeable pulleys which are applied to the wheel-spindle.

On the front of the machine at the left-hand side there are two gear-boxes. The lower one provides two speeds for the eccentric head, these speed changes being controlled by lever *D*, Fig. 4, which operates friction clutches of the expanding type. This speed regulating box is connected with the main driving shaft at the rear by a cross belt which extends through the machine base. This belt connects with the pulley *E* on the lower shaft of the speed-box. When friction clutch *F* is engaged by lever *D*, the upper shaft is driven at the higher speed, and when friction clutch *G* is engaged, the speed is reduced. Motion is transmitted from the upper shaft by means of pulley *H* and a belt to a shaft above carrying a fabroil pinion which meshes directly with the large gear of the eccentric head. The lower shaft of the speed-box also carries a pulley *J*, which transmits motion by a belt to the lower shaft of the feed-box above.

This feed-box contains a double cone of gears and a sliding key, and provides for three rates of feed or speed at which the work can be fed past the wheel. These changes are controlled by lever *K*. The feed-box is connected by a shaft seen extending along the front of the machine (Fig. 1), with the automatic reversing mechanism on the right-hand end of the bed. This is a plain shaft as will be seen, universal joints used in the older machine to provide for vertical adjustment not being required. The reversal of the table may be controlled independently by hand-lever *L*, and the movement of the table may be started and stopped by lever *M*, (See also Fig. 5) which operates a friction clutch inside of the base. Shaft *N* is revolved by a crank when a hand adjustment of the main table is desired. The main table is equipped with limit stops which automatically reverse its travel at the extreme ends of the stroke so that it is impossible for the operator to run the table rack out of mesh with the driving pinion. All of these control levers are within a radius of 18 inches so that they can be reached very easily without stooping and with the least possible effort.

The grinding wheel spindle of this machine is carried in a double eccentric head, which is the same design used on the No. 60 machine. This eccentric head also has a micrometer adjustment for readily varying the diameter of the hole being ground, and also the automatic adjustment which can be made to operate at each revolution of the eccentric head. In order to secure greater rigidity, especially for the grinding of large cylinders containing four or six bores en bloc, the base of the machine has been widened considerably. The ways on which the main table slides are of the dovetail form and a gib is provided on one side so that all play can be eliminated. Oil pockets and rolls provide ample lubrication. The length of the main table is such that the bearing

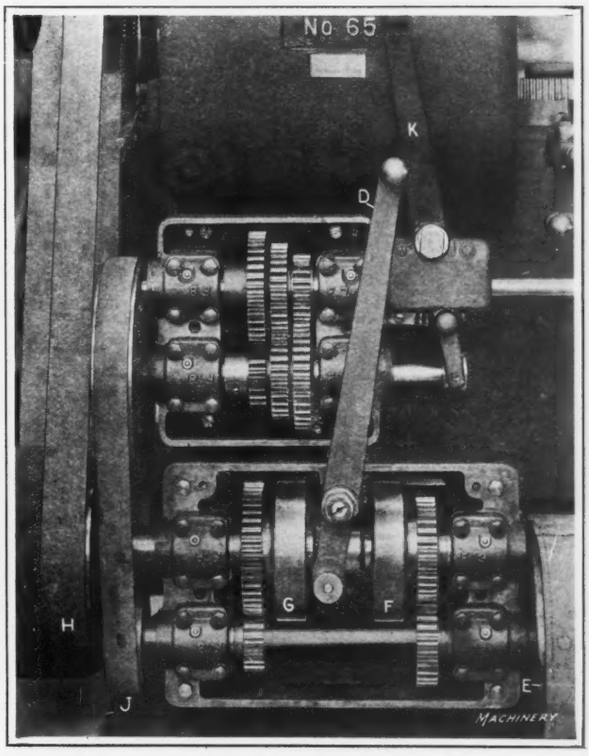


Fig. 4. Detail View of Gear-boxes for controlling Speed of grinding and Rate of Table Travel

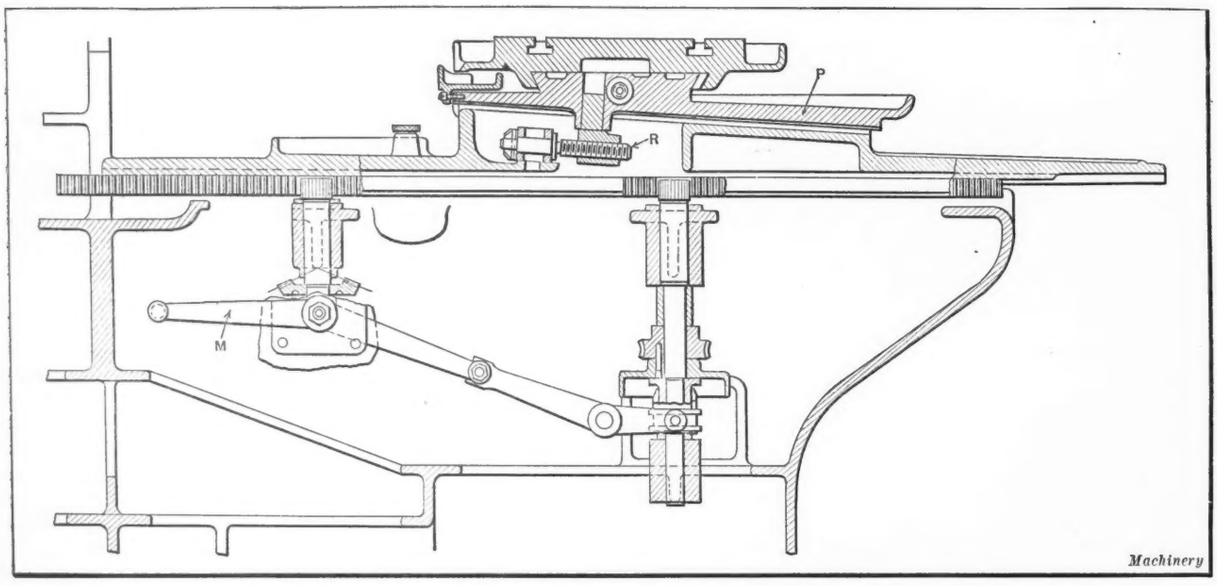


Fig. 5. Longitudinal Section through Cross-slide Table, Intermediate Slide and Main Table

surfaces are protected from grit and dirt. The intermediate slide and the cross-slide table also have the dovetail ways with gib adjustment. This cross-slide table has a 24-inch lateral movement and it corresponds in size to the table of the No. 60 machine. It is 36 inches long, 18 inches wide, and has a finished top measuring 14 by 28 inches. The maximum and minimum distances between the top of the cross-slide table and center of the grinding circle are 7 15/16 and 7 13/16 inches, respectively. The feed-screw of the cross-slide table has a graduated dial reading to thousandths of an inch, and adjustable dogs are also provided for indicating the center-to-center distances between cylinder bores.

The main driving shaft at the rear carries a pulley for driving the lubricant pump (see Fig. 2) and also a pulley for revolving the exhaust fan in case the machine has an independent exhaust system. The work-table and intermediate slide are arranged to catch the lubricant which flows to a channel or trough at the rear of the bed and then into the pump tank. The cover of this tank has several compartments or partitions so arranged that most of the sediment is removed before it enters the tank proper. The latter is also provided with a partition for catching any sediment that may remain. The pump is of a horizontal centrifugal type which is very compact in its design. The improvements in this cylinder grinder are the result of a careful study of the requirements of the manufacture and the result of ten years' experience in building machines for grinding cylinders accurately and efficiently.

KENT "KEG-KONVEYOR"

To provide for the rapid handling of kegs filled with light or heavy material, the Kent Machine Co., Kent, Ohio, has placed upon the market a device known as a "Keg-konveyor." It is of very simple construction, easily operated, and is said to have a capacity for moving more kegs in a specified time than many other forms of handling devices which can be operated by one man. The Kent Keg-konveyor is practically automatic in action. When the operator becomes accustomed to its use, he approaches the keg with the hoop up against the handle of the konveyor; then by a single movement he drops the hoop over the keg and brings the handle down ready to start pulling the load. Two spurs on the lower part of the device help to pick up the heaviest load and prevent the keg from slipping while it is being transported.

The wooden parts of the keg-konveyor are made of ash with wrought-iron braces. The device is light although strong and durable. It is a matter of experience that in many devices used for handling freight the greatest strain

Fig. 1. Picking up a Keg for Transportation on the "Keg-konveyor" made by the Kent Machine Co.

Fig. 2. How the Kent "Keg-konveyor" holds its Load during the Time it is being carried

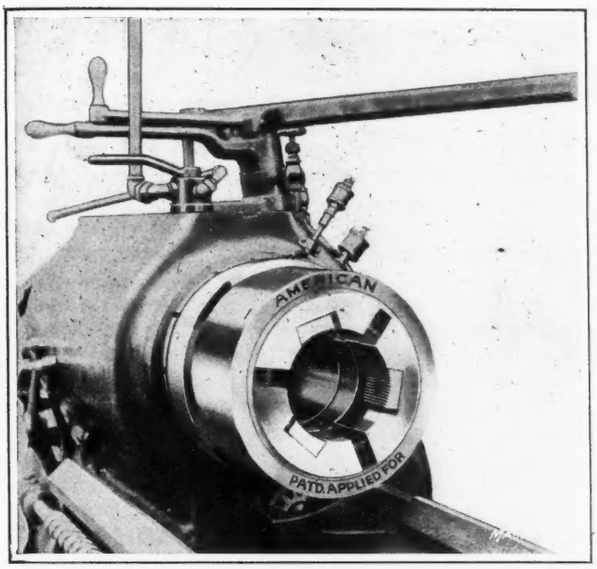


Fig. 1. American Pneumatic Collet Chuck set up on Steinle Turret Lathe

does not necessarily come at the time when the load is being picked up or carried. Destruction is more likely to result from abuse resulting from carelessness of the operator while the truck is running light. In working out the present design, particular attention has been given to the provision of means for withstanding the roughest handling.

the air pressure in this factory varies considerably, the test was conducted by reducing the pressure to 40 pounds per square inch, and in employing the coarsest feed provided on the machine. Working under these conditions it is stated that the chuck held the shell without allowing it to slip in any way. Subsequently, these chucks were used with an air pressure of 15 pounds per square inch and are said to have given satisfactory service.

HAYNES "TIP-IT" COMPOUND FOR WELDING STELLITE TO STEEL

Many experiments have been carried on with a view of devising a satisfactory means of welding or brazing a stellite bit to a carbon steel shank. In the April number of MACHINERY an article was published describing the brazing of stellite by the copper method. Since that time there has been put on the market a welding compound known as "Tip-it," which is made by the Haynes Stellite Co., Kokomo, Ind. This company states that it has found this to be the most economical, most efficient, and the easiest applied of any process yet discovered. The claim is made that this is the most economical and the most easily applied because of the fact that a weld can be made with an ordinary forge or a coke-, gas-, or oil-heated furnace, as long as it is possible to obtain a heat of 2000 degrees F. The method of procedure is to cut the shank out as noted in the accompanying illustration, to form a recess for the bit. The steel shank and the stellite can then be placed in the fire, although if it is obtainable, a preheating chamber is best.

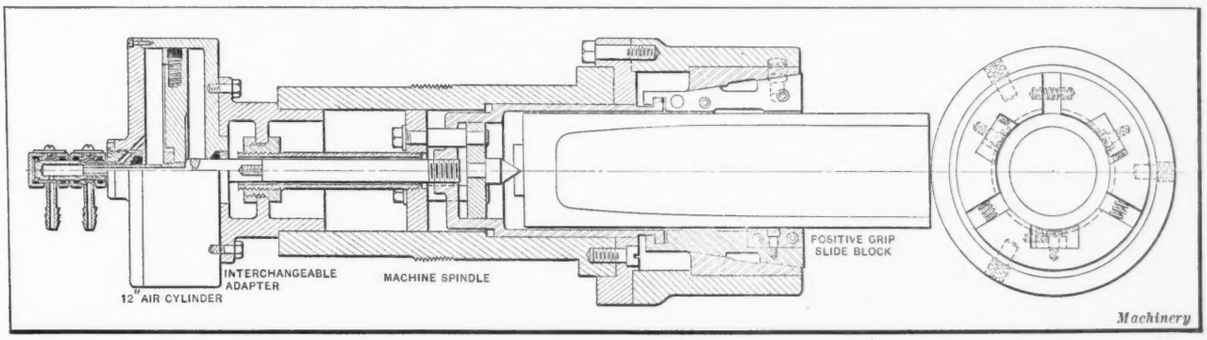


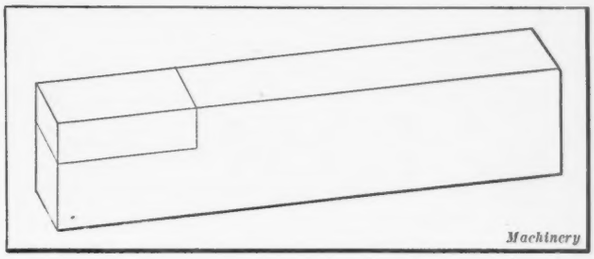
Fig. 2. Longitudinal Section through the American Pneumatic Collet Chuck, Lathe Spindle, and Air Cylinder

AMERICAN PNEUMATIC COLLET CHUCK

For use on heavy-duty machines the American Pneumatic Chuck Co., 9 S. Clinton St., Chicago, Ill., has designed a positive-grip hinged collet chuck which is shown in illustrations which accompany the following description. It is stated that this chuck has a capacity for holding the work without slipping under the most severe conditions of service. The pull of the draw rod is applied directly on the jaws, relieving the hinge pin of all strains and ensuring perfect alignment of the jaws at all times. A long gradually tapered bearing on the collet affords a powerful grip which is increased by sliding hardened tool steel grip blocks with milled teeth which are inserted at the front end of the jaws. In the event of the air pressure being reduced or the cut increased to a point which would cause the work to start slipping, these grip blocks will slide in the jaw slots which are milled on a taper, thereby affording the necessary increase in the grip of the chuck. Perfect alignment of the work is maintained by an additional plain gripping surface at the rear end of the jaws.

It is claimed that a chuck of this type can be operated with a smaller air cylinder than is usually required, thereby saving a considerable amount of air and reducing the operating cost. While primarily designed for use with a 12-inch air cylinder in holding 6-inch steel forgings for a rough-boring operation, this chuck can be employed for holding many other classes of work. At the shop of the Briscoe Motor Corporation these chucks were given a very severe test in rough-boring 155-millimeter steel shell forgings. As

Both the stellite and the shank should be brought up to a temperature of about 1600 degrees F., at which time they may be removed, the scale scraped from the shank, a thin layer of Tip-it compound spread along the recess for the bit, the bit put in place and then replaced in the fire. The temperature should then be brought up, and when about 1800 to 1850 degrees F. is reached the compound will begin working in the joint. When a temperature of about 1900 to 1950 degrees F. is reached, there will be a fine bluish flame come out from between the stellite and the steel and work up the tool bit. When the temperature that produces this flame is reached, the tool should be removed from the fire, and a pressure brought to bear along the entire length of the bit. This pressure needs to be only slight, say about 50 pounds, to the square inch. As soon as this pressure is applied the weld is completed, and the tool can be handled as one piece.



Example of Steel Shank cut away to receive Stellite Bit Ready for welding with "Tip-it" Compound

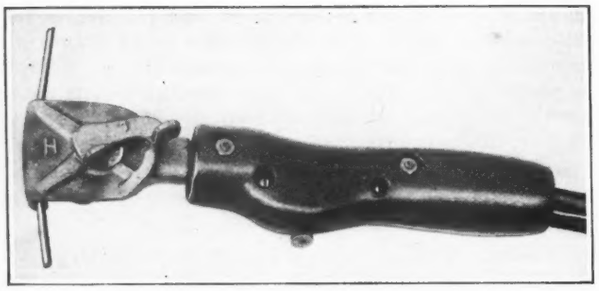


Fig. 1. Improved Arc Welding Tool manufactured by the Arc Welding Machine Co., Inc.

IMPROVED ARC WELDING TOOL

In arc welding, a considerable portion of the operator's time is consumed in changing welding electrodes. Up to the present time a large variety of welding tools have been developed and placed on the market. The oldest forms consisted of spring tongs which had to be spread apart by an instrument similar to an off-set screwdriver, when it was desired to insert the electrode and release it. Another type employed a pair of tongs that could be operated by a thumb-lever. The disadvantage of this scheme was that in case the electrode stuck to the work, the operator released the tool, drawing an arc between the tongs and the electrode, which practice soon destroyed the tongs.

The type in most common use today, employs a strong compression spring. If this spring is strong enough to hold the electrode when it freezes to the work, so that the electrode cannot be pulled away from the tool, it requires considerable strength to operate it, and therefore it is not always well suited where girl operators are employed. The present development, first of all, was designed to make the operation of changing electrodes absolutely definite, so that in production work it could be counted upon. The next was to make an instrument that would hold the electrode and permit any amount of pull, in case the electrode froze to the work without releasing; at the same time it is operated easily for voluntary release.

The tool which resulted from these studies is shown in the accompanying illustrations. The welding current enters at the rear end of the composition shank, passes along the shank to the head of the tool, and from there directly into the electrode. It will be noted, that there are no joints in this tool except where the cable is soldered into the shank. Therefore, heating due to contact resistance cannot occur. There is a relatively large contact surface between the electrode and the holding head, which precludes any possible heating at this point. The electrode is clamped by a spiral segment operated by a lever. The lever is thrown to the widest open position and the electrode inserted, when the lever is turned in the opposite direction as far as it will go. Any attempt to pull out the electrode, results in tightening the grip of the segment which is made of casehardened steel. The trigger is intended for remote control employed with the closed-circuit system manufactured by the Arc Welding Machine Co., Inc., 220 W. 42nd St., New York City.

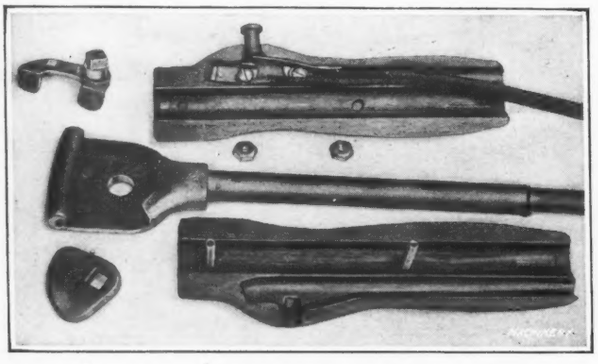
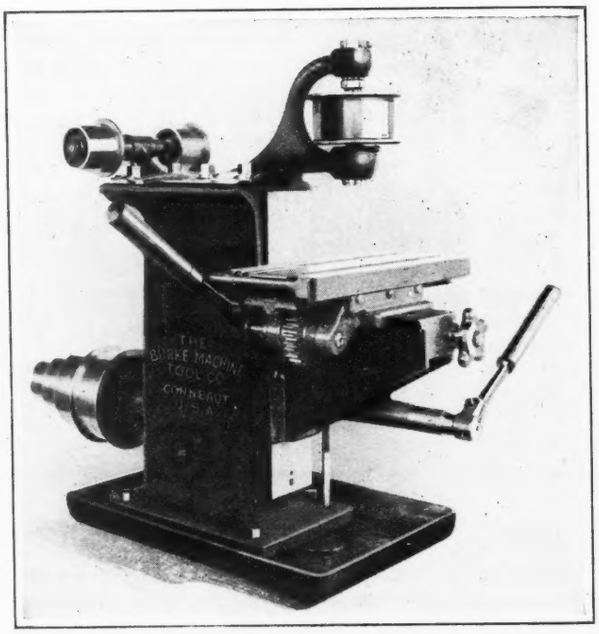


Fig. 2. Parts of the Arc Welding Tool shown in Fig. 1

Whenever this electrode-holder is used on systems other than that specified, the trigger is omitted; otherwise it is the same.

BURKE VERTICAL MILLING MACHINE

A vertical bench milling machine has been brought out by the Burke Machine Tool Co., Conneaut, Ohio. This machine is intended for any small vertical milling that may be required in shops handling medium-sized or small work. The reason for bringing out this machine was that there was such a demand for the vertical milling attachment supplied in conjunction with the Burke Machine Tool Co.'s horizontal bench milling machine, that it became apparent that there was a need for a machine of the vertical type. Horizontal, vertical and traverse hand-feeds are provided, the longitudinal feed of the table being 6 inches, the traverse feed being 4¼ inches, and the vertical feed or motion of the knee, 11 inches. The machine is driven by a belt to a cone pulley at the rear of the machine as indicated, the driving belt to the vertical spindle passing over idlers at the back of the column as shown. The driving belt is 2 inches wide, the smallest diameter of the cone 3½ inches, and the largest diameter 6 inches, the cone having three steps. The loose pulley on the



Vertical Bench Milling Machine built by the Burke Machine Tool Co.

countershaft is 7 by 2¼ inches, and the countershaft speed 280 revolutions. The height over-all of the whole machine is 28 inches, its weight being 300 pounds complete, or weight boxed 400 pounds.

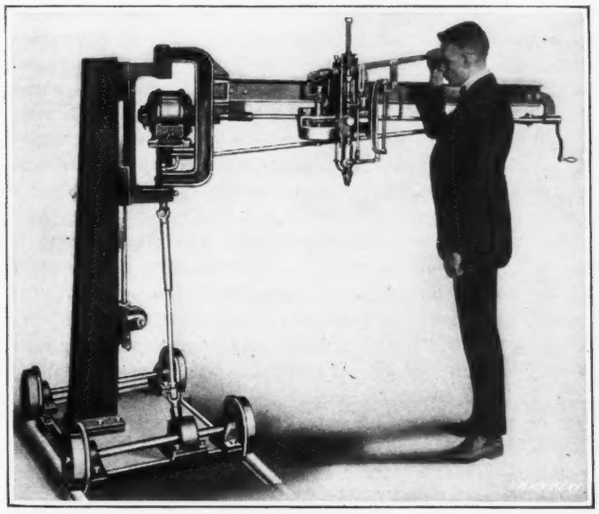
As regards the capacity of the machine, it might be mentioned that the working surface of the table is 5¾ by 15 inches. The bracket holding the vertical spindle is adjustable so that it may be placed in two positions; in one position the distance between the center of the spindle and the face of the column is 1 inch, while in the other position the distance is 6 inches. The taper hole in the spindle is for a No. 7 Brown & Sharpe taper shank, while the hole through the spindle is 9/16 inch. The machine shown in the illustration has all hand-feed, but it is also built with power feed if required.

REYNOLDS TRAVELING RADIAL SCREW-DRIVING MACHINE

Where screws are driven into work that is too large to be conveniently handled, a machine must be taken to the work. Driving screws mechanically is not new but the development of methods of handling and driving screws

mechanically, and in a measure automatically is of comparatively recent date. Work that is too heavy to manipulate by hand but that comes within a convenient range of dimensions can be served by a machine of the radial type carried by a suitable post or column, the work in this case being carried by a truck or otherwise placed within range of the radial arm. For a class of work that may be built up on a bench or special form and that has screws driven before removal from the bench or form, a movable or traveling machine of this character has recently been designed by the Reynolds Machine Co., Massillon, Ohio. It is known as the Reynolds No. 5 radial, which can be equipped to handle a range of screws varying from No. 2, 3/8 inch in a length, to No. 8, 1 inch long. It is essentially a radial type of machine hung from a column, which, if desired, may be made movable upon a track made alongside the work or form bench.

The usual spindle bearing driving mechanism and magazine are mounted on a head which is carried on an I-beam attached to a pivoted bracket. It turns in pivot bearings in a saddle which is mounted on a column and is adjustable for height within any convenient working range. This column may be mounted on a stationary base or, if desirable, it can be attached to a base having wheels that run on and are guided by track rails. The head carrying the magazine and spindle mechanism is mounted on the I-beam with roller bearings, making it very easy of operation for lateral adjustment. The power is provided by an electric motor mounted on a pivoted bracket and coupled direct to a splined shaft carried under the beam.



Traveling Type of Radial Screwdriving Machine built by the Reynolds Machine Co.

The carriage or base has the wheel axles mounted in ball bearings. The carriage is moved by hand cranks placed at the end of a beam near the operator's usual position, the connection to the axle being by means of shafts and universal joints. The carriage is also provided with gibs to connect with the rails as a measure of safety against accidental overturning. In operation, the driving of screws can be started at either end of the work and longitudinal lines of screws can be driven by combining the swing of the arm, the movement of the head on the arm, and the movement of the carriage. The lateral or angular lines of screws are driven by movement of the head or arm, swinging the arm and moving the base to new positions as required. While any range of action within reach may be secured, this No. 5 radial will cover a width of 36 inches giving angles of 30 degrees, or a width of nearly four feet in direct cross-lines at right angles to the column. Obviously any reasonable length can be secured by making provision for the electric wires. The controller for operating the motor is carried by the same bracket that carries the motor, thus bringing it within easy reach of the operator.

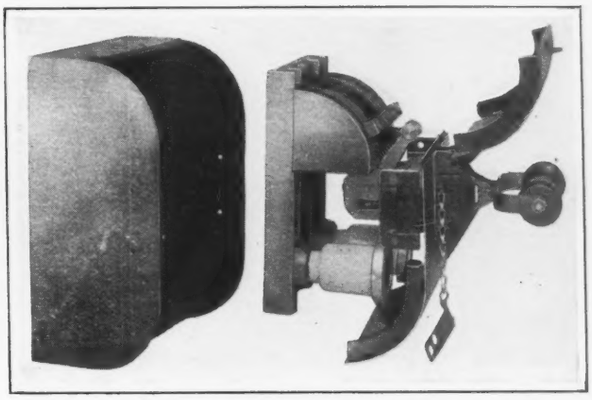


Fig. 1. General Electric Motor Starting Switch with Time Limit Overload Protective Device

GENERAL ELECTRIC OVERLOAD PROTECTIVE PLUGS

The Type CR 1038 switch as manufactured by the General Electric Co., Schenectady, N. Y., is designed for connecting alternating-current motors up to 3 horsepower 110 volts and 5 horsepower 220, 440, and 550 volts, direct on the line. This switch contains a feature other than the quick make-and-break device which will no doubt be of interest, and that is the time overload protective plugs which are located immediately below the switch proper and inside the sheet-iron case covering the whole device. These protective plugs, as shown in Fig. 2, contain a stationary contact post with heating coil *A* and a fusible joint *B* which binds a spring contact arm to the stationary post. The motor circuit is completed through the heating coil, post, link, and spring contact arm. In case of an overload, the current passing through the heating coil will heat the post sufficiently to melt the low fusible alloy that holds the link together, thus releasing the spring contact arm and causing it to take the position as shown by the dotted line *D*, thereby opening the circuit between the contact arm and the post.

These fusible links, which cost but very little, are easily renewed, simply by slipping the link down over the end of the post and fastening the spring contact arm under at the same time. The successful operation of the protective plug depends upon the special low fusing alloy which holds the link together, and only new links manufactured by the General Electric Co. should be used with these plugs. By reason of the time lag feature, the momentary inrush starting current will not cause the plug to open the circuit. The plugs protect the motor from any conditions of overload that, if maintained for a sufficiently long period, would overheat the motor. Under such conditions (all multiphase motors running single-phased; motors stalled, and an attempt made to start them; or motors called upon to drive too heavy a load) the plugs will open the circuit in time to save the motor.

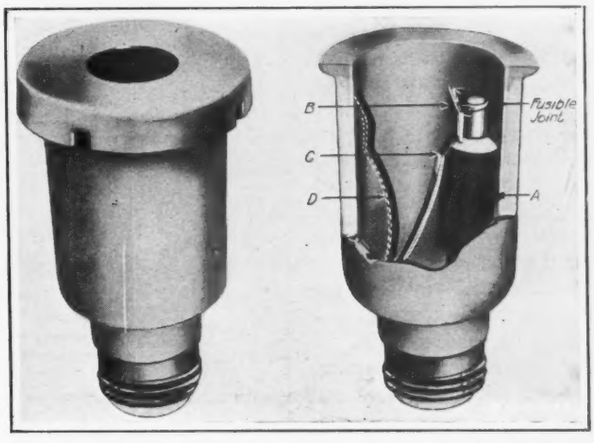


Fig. 2. Protective Plugs used in Motor Starting Switch shown in Fig. 1

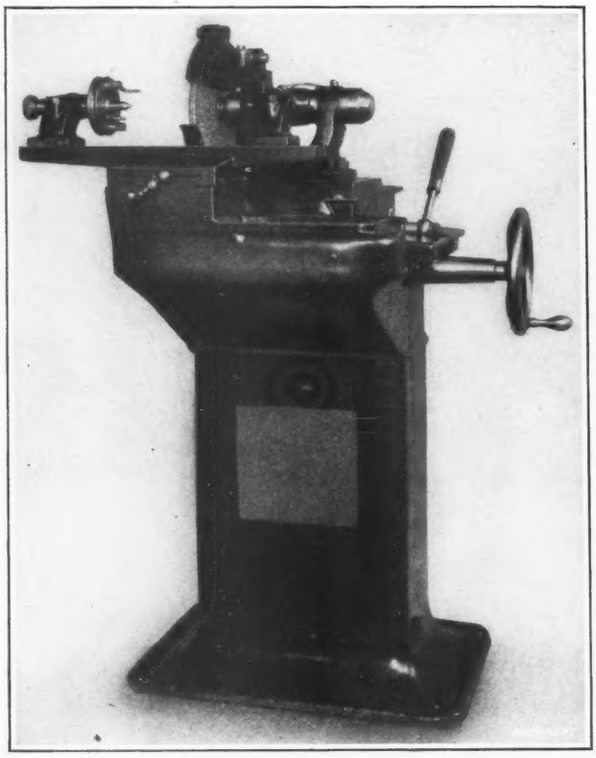


Fig. 1. Operating Side of Profile Grinding Machine built by the Fischer Machine Co.

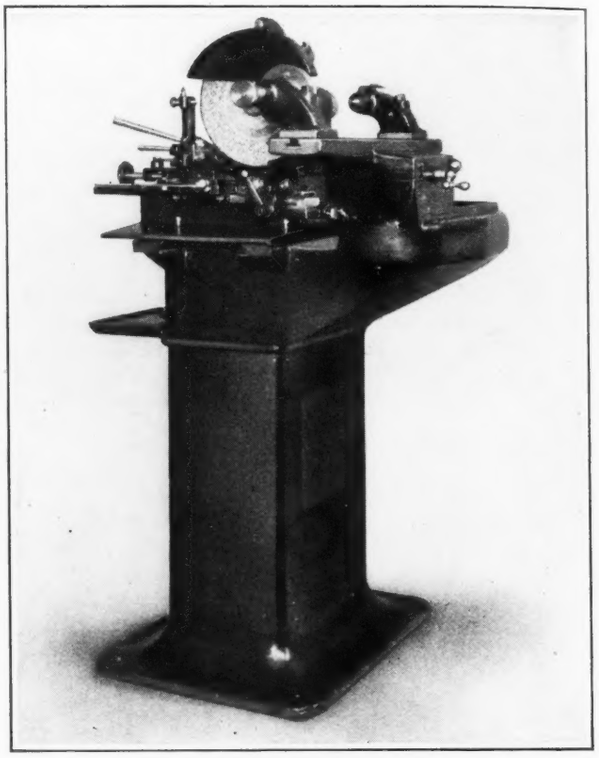


Fig. 2. View of Profile Grinding Machine showing Work-holding Centers and Diamond Attachment

FISCHER PROFILE GRINDING MACHINE

There are many tool-rooms in which it is required to grind formed punches and other parts where a very high degree of accuracy is necessary. In order to increase the speed of performance of such operations, the Fischer Machine Co., 310 N. 11th St., Philadelphia, Pa., has placed upon the market a profile grinding machine shown in Figs. 1 and 2, and in Fig. 3 there are illustrated three examples of the general class of work for which this type of machine is adapted. It is claimed that profile grinding operations can be performed with this equipment with assurance that the dimensions will be held within a limit of 0.0005 inch. In preparing to use this machine for the performance of a profile grinding operation, the first step is to make a flat master form of exactly the same longitudinal section and size as that of the round work which is to be ground. This form is secured to a bracket on the frame of the machine and is engaged by a former pin carried by the cross-slide on which the grinding wheel-head is mounted. It will be seen that the wheel-head is carried by a compound slide, and by referring to the view of the operating side of the machine shown in Fig. 1, there will be seen a handwheel and a long lever. The operator holds the lever in his right hand and the wheel in his left. The lever provides for throwing over the cross-slide so that the former pin is always kept in contact with the master form, and then by turning the handwheel, the longitudinal slide may be reciprocated back and forth to provide for traversing the grinding wheel over the work to be ground.

Centers are provided for supporting the work and longitudinal adjustment of these centers furnishes means of both handling work of various lengths and of bringing the work exactly opposite to the master form. In addition to the main adjustment the head center is furnished with screw-operated precision, longitudinal adjustment, and the tail center is held in contact with the work by means of a compression spring. In this way the head center may be moved forward or back by tightening or loosening the screw, and the spring tension behind the tail center will allow the work to move in either direction as required. A pivoted support is provided for the bracket on which the master form is carried, and by means of a screw adjustment this bracket may be swung on its pivot to provide for bringing the center line of the form parallel to the center line of the centers on which the work is carried. In this way means are provided for assuring having the work ground concentric with its true center line.

In using a machine of this kind it is essential to have the grinding wheel carefully trued to the required form. Two points must receive consideration, namely, the wheel must be kept in such condition that it has an accurate cutting surface, and the shape of the wheel must be the same as the shape of the former pin so that as the pin runs over the master form, the point on the pin which is in contact with the form will correspond exactly to the point on the wheel which is doing the grinding on the work. If this duplication of the shape of the grinding wheel and former pin is not maintained, it will be impossible to have the grinding wheel reproduce the shape of the master form on the work. A diamond truing device is provided on the machine for use in dressing the grinding wheel and this will be clearly seen at the back of the wheel in Fig. 2. A gage is provided to enable the diamond to true the wheel to exactly the same shape as the former pin.

One screw adjustment feeds the diamond in to compensate for the reduced diameter

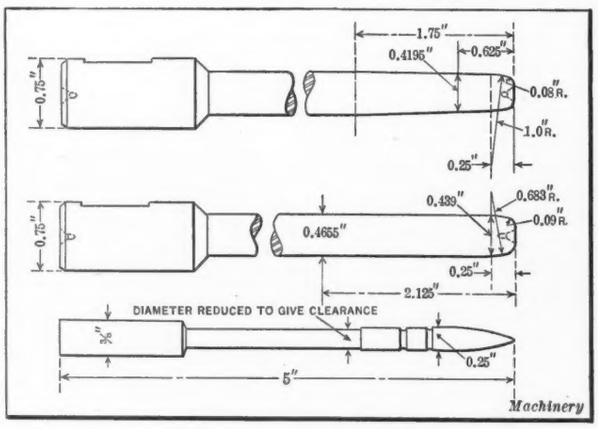


Fig. 3. Examples of Work done on Fischer Grinding Machine

of the wheel, and there are also pivotal and straight-line movements of the diamond to provide for dressing one part of the wheel to any desired contour, and another part to a straight line. Obviously, in grinding such work as the punches shown in Fig. 3, a straight section of the wheel is required for grinding the cylindrical portion of the work, while a curved section of the grinding wheel must be employed for grinding the irregular contour. It will be seen that the brackets which support the centers by which the work is carried, are mounted on a cross-slide which is operated by a handwheel. This slide is a convenience in setting the machine ready for the performance of a grinding operation on work of any specified diameter. It will also be noted that there is a shelf at the front of the machine column on which tools, work, etc., may be placed in a position which is convenient for the operator.

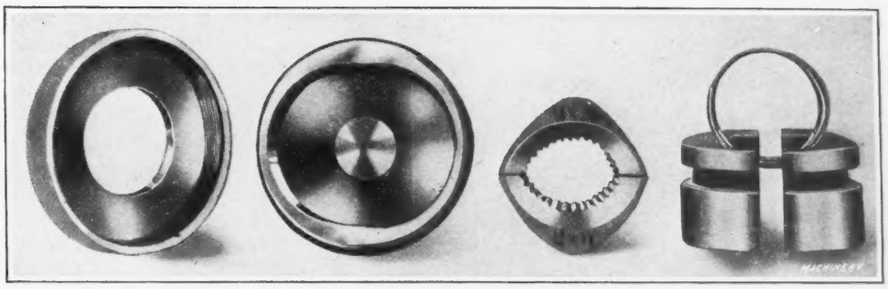
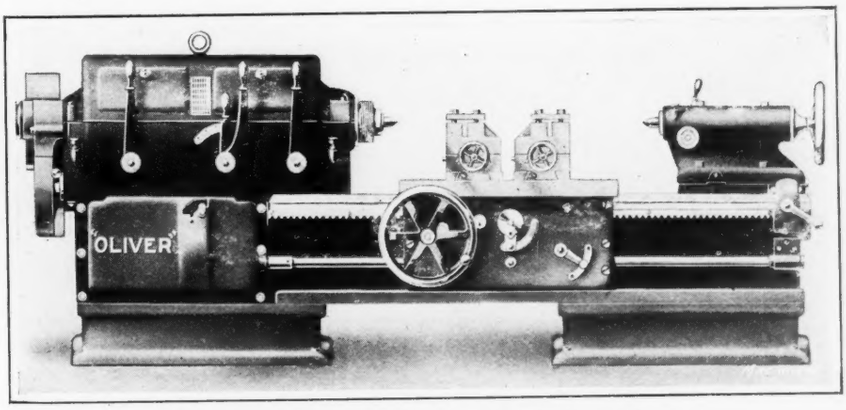


Fig. 2. Parts of the Gustin-Bacon Driving Chuck, showing Two Styles of Jaws

OLIVER SHELL LATHES

The Oliver Machinery Co., Grand Rapids, Mich., manufactures a line of engine lathes comprising machines of 16, 18, 26, and 30 inches swing. All of these standard lathes have been made over into special shell machines. In the accompanying illustration there is shown the No. 87 Oliver shell lathe which swings 28 inches. It will be seen that an all-geared head is provided and the machine is of heavy construction. Either individual motor drive or belt drive from a lineshaft may be employed to transmit power to the single driving pulley.

The design has been worked out along lines which afford heavy and coarse feeds. This is practically a single-purpose machine. The control has been simplified as far as possible to adapt the machine for operation by unskilled labor, and all gears are made of steel. All pinions are cut from steel forgings and the spindle is forged from high-carbon steel and accurately ground to size. The bearings are liberally proportioned and provided with bronze bushings which are adjustable to compensate for wear. Application has been made of the double wall type of apron which has a removable front plate to permit easy access to the internal mechanism without requiring the apron to be removed.



No. 87 Shell Lathe built by the Oliver Machinery Co.

GUSTIN-BACON REVERSIBLE DRIVING CHUCK

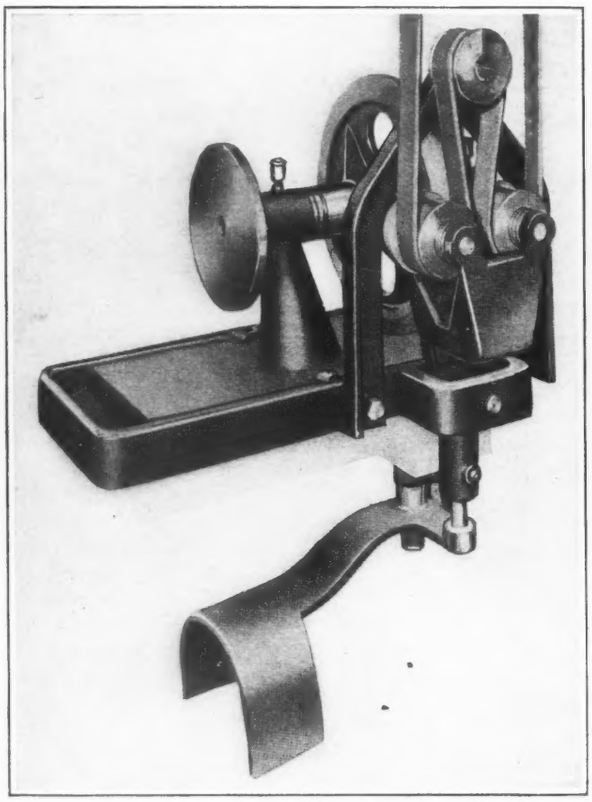
For use in running staybolts into fireboxes and for driving straight shank reamers, taps, and similar tools, the Gustin-Bacon Mfg. Co., 1416 W. 12th St., Kansas City, Mo., is now making a reversible driving chuck which is illustrated in Fig. 1. This gives a general idea of the design, and in Fig. 2 there are shown the screw cap for holding the jaws in place, an inside view of the chuck body, and two types of jaws for holding round bolts and square-headed bolts, respectively. It will be apparent from the shape of the jaws and the inside form of the chuck body, that provision is not only made to prevent the jaws from revolving, but that the grip of the jaws is increased with an increased pull of the driving motor or increased resistance to the rotation of the tool or work which is being driven. One of these chucks will accommodate round bars varying 5/16 inch in diameter without requiring the jaws to be changed, and a positive grip is assured without changing the jaws either for running in or removing staybolts.

Fig. 1. Reversible Driving Chuck made by the Gustin-Bacon Mfg. Co.

It is claimed that this chuck always runs central. An important feature in the use of this tool is that the jaws continue to hold the work when it is necessary for the motor to be reversed to back out a bolt which has been run in too far. No time need be spent in squaring the ends of staybolts, because the jaws will hold a round bar without the least tendency to slip. Jaws to accommodate round bolts ranging from 15/16 to 1¼ inch in diameter are carried in stock, and special sizes are made to order. When so desired, jaws may be furnished to drive square-headed bolts, and one of these sets of jaws will accommodate any size between ⅝ and ⅞ inch without change. The jaws are made of heat-treated tool steel and are sufficiently durable to last for many months under ordinary conditions of service.

BEACH LAPPING MACHINE

The Beach Mfg. Co., Boston, Mass., is now making a No. 1 lapping machine which is illustrated and described herewith. It will be seen that a knee type of controlling device is provided, which leaves both hands of the operator free to manipulate the work. In this way the speed at which lapping operations

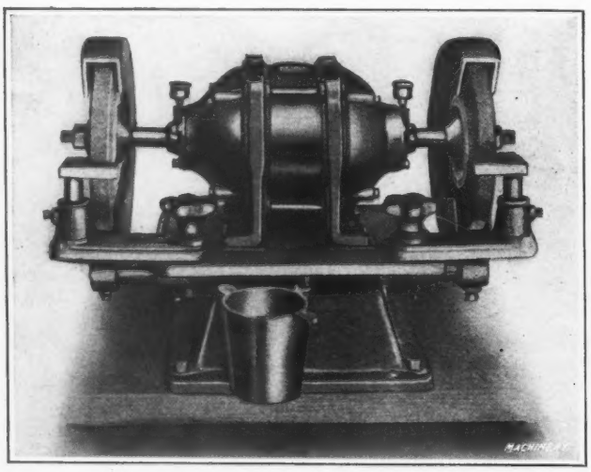


No. 1 Lapping Machine built by the Beach Mfg. Co.

can be conducted is substantially increased. This machine swings 10 inches in diameter and is fitted with bronze bearings, ball thrust bearings, and suitable provision for lubrication. Although originally designed for use in lapping plug and ring gages, the machine is said to be an efficient tapping machine. It is furnished with a pull countershaft and faceplate ready to be fitted to the chuck. Either a universal geared scroll chuck or a drill chuck may be used, according to the nature of the work.

U. S. ELECTRICAL BENCH GRINDING MACHINE

In the accompanying illustration there is shown a bench type of electrically driven grinding machine, which is a recent product of the U. S. Electrical Mfg. Co., 459 E. Third St., Los Angeles, Cal. In its general features, this machine is quite similar in design to the column type of electrically driven grinding machine of this company's manufacture. The chief difference is that the present machine is adapted for setting up on a work-bench instead of on the floor.

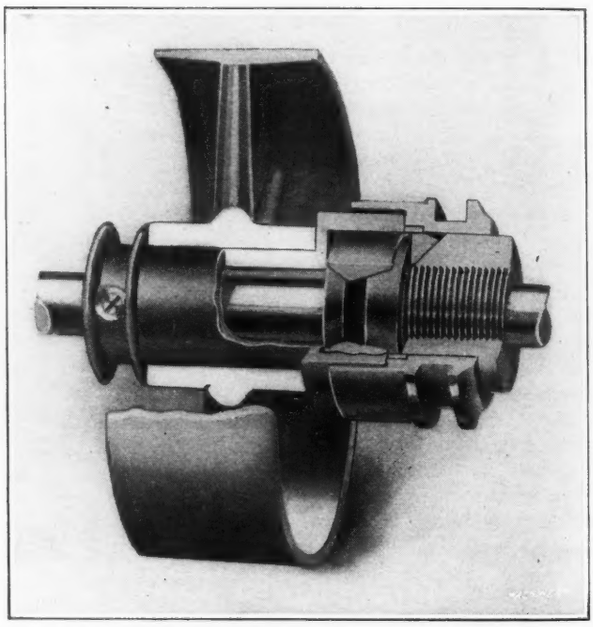


Bench Type of Grinding Machine built by the U. S. Electrical Mfg. Co.

Either grinding or buffing operations may be performed. Machines of this type are made in six different sizes equipped with ½-, 1-, 2-, or 3-horsepower motors. The ½-horsepower machine is adapted for operation at from 1500 to 1800 revolutions per minute; the size of grinding wheels used, 10 by 1 inch; diameter of wheel-spindle, ¾ inch; distance between wheels, 20 inches; length of spindle, 25 inches; size of base, 13 by 14 inches; height from bottom of base to center of spindle, 11½ inches; and approximate shipping weight of the machine, 235 pounds.

HANSON FRICTION CLUTCH

The Hanson Clutch & Machinery Co., Tiffin, Ohio, is now manufacturing a friction clutch which is of compact and simple design and is said to possess ample power for the various capacities in which it is made. A single nut provides means of making uniform adjustment and the clutch is carefully balanced so that it will run at high speed without developing noise or vibration. The mechanism is completely enclosed and operates in an oil bath, and there are no projecting parts which may result in injury to the machine operator. Pulleys are made with spokes cast onto the ring which receives the friction, an expanding type of friction



Friction Clutch made by the Hanson Clutch & Machinery Co.

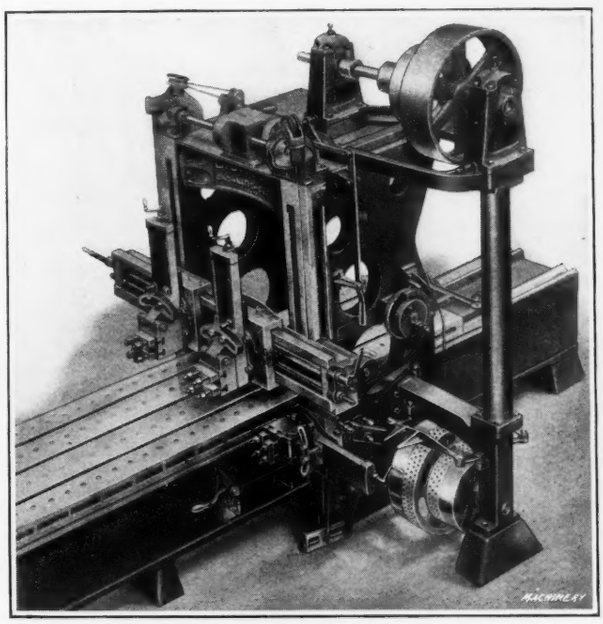
being employed which grips the entire ring. A complete line of these friction clutches are made, including countershaft, extended-sleeve, and machine clutches. A double clutch is also made with two friction cylinders with sleeves for mounting pulleys, gears, sprockets, etc., the dimensions of the sleeves varying to suit different requirements.

IMPROVEMENTS IN BICKETT PLANER

The Bickett Machine & Mfg. Co., Cincinnati, Ohio, has introduced a number of improvements in the standard design of planer being built by the company in sizes 36 by 36, 42 by 42, and 48 by 48 inches. The improvements relate to the overhead countershaft drive. In the ordinary type of overhead drive, where the pulleys are mounted in a bracket supported from the housing only, there is considerable vibration when the machine is running. Furthermore, when 3-ply endless belts are employed, as is now the practice in planer drives of this type, the tightening of the belt when first applied produces an undue strain on the bearings, and not infrequently the bearing boxes burn out, due to the friction and the consequent heat produced. The improvements made in the Bickett planer overcome these difficul-

ties. The undue vibration is eliminated by providing the overhead countershaft bracket with an outboard support, as shown in the illustration, this support consisting of a cast-iron pipe column resting at the floor on a substantial cast supporting base. This construction provides a rigid support for the overhead countershaft.

The difficulty due to too severe tightening of the endless belts employed is overcome by having the bearings for the countershaft adjustable, both in a horizontal and in a vertical direction. By means of the vertical adjustment it is possible to so correct the location of the countershaft that the proper belt tension may be secured. However, when the bearing is adjusted vertically, it is evident that the gear on the countershaft meshing with the driving motor gear will be moved with relation to this gear and will not be properly in mesh with it. Provision for bringing it back into proper mesh is made by having the bearings adjustable in a horizontal direction also, thereby making it possible to place the gear on the countershaft in proper mesh with the driving gear on the motor, no matter what the vertical adjustment of the countershaft may be. The bearings are self-oiling bronze-lined bearings. No change has been made in the design of the planer itself, which is the regular Bickett planer with box-type table and enclosed-top bed.



Improved Type of Planer built by the Bickett Machine & Mfg. Co.

UNIVERSAL DRAFTING PEN

For use in ruling either solid or a variety of different dotted and broken lines, the Universal Drafting Pen Co., Inc., 27 Cannon St., Bridgeport, Conn., has placed upon the market the "Berggren" drafting pen which is shown in Figs. 1 and 2. It will be apparent that this pen is provided with a wheel in the periphery of which a groove is cut to carry ink used in ruling the line. The periphery of this wheel may be continuous if the pen is to be employed for ruling a solid line, or it may be notched with various combinations of spaces if the pen is required to rule broken or dotted lines. The regular equipment furnished with the pen consists of six wheels which may be of any desired form to meet the requirements of the user's work. A total of thirty different types of wheels are made so that the selection may be made to cover a wide range of work.

In a general way, this pen is of somewhat similar design to the standard form of draftsmen's ruling pen; that is to say, a supply of ink is held between the two nibs. Carried on a stud between the points of these nibs, there is the wheel to which reference has already been made. This wheel draws ink from the reservoir held between the nibs and distributes it along the line in either a continuous stream or in alternate deposits, according to the shape of

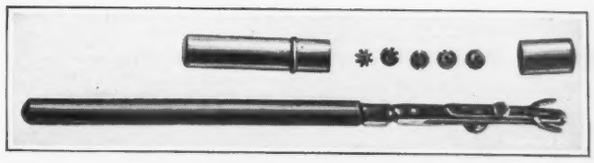


Fig. 1. "Berggren" Drawing Pen made by the Universal Drafting Pen Co., Inc.

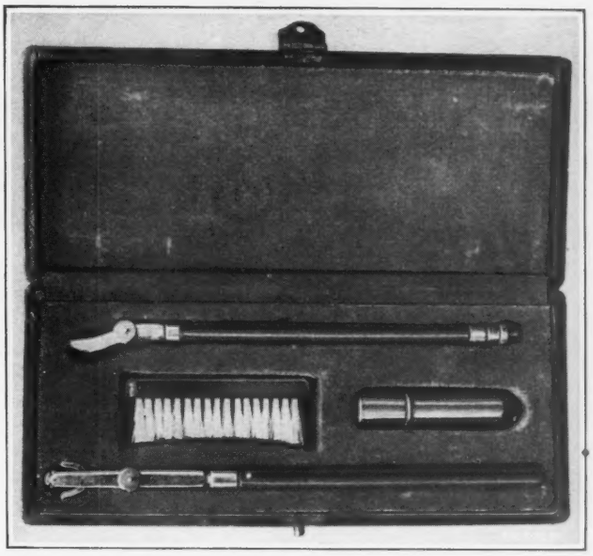


Fig. 2. "Berggren" Drawing Pen shown in its Case, with Brush and Container for Extra Wheels

the wheel. In addition to provision made for ruling solid and broken lines, wheels are furnished in three different widths to meet different requirements. At either side of the nibs it will be seen that there is a forked guard which runs in contact with the straight edge. The use of this guard is a great convenience, as it effectually prevents danger of blotting the work. The wheels are very easily put on or taken off, it being merely necessary to open the pen as in the case of cleaning. Then a stud carried by one nib of the pen comes out of its hole in the other nib, so that the wheel can be lifted off. In addition to the thirty standard wheels which are made, special wheels can be supplied on order.

RED-E HIGH-SPEED CUTTERS WITH CARBON SHANKS

The Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn., is now successfully welding high-speed steel cutter-heads onto low carbon steel shanks. This result is accomplished by a process of electric welding and is said to give very satisfactory results. Where tools of the form shown in the accompanying illustration are made entirely of high-speed steel, it is obvious that the blank must be of sufficient size for the cutter-head and as a result there is a serious waste

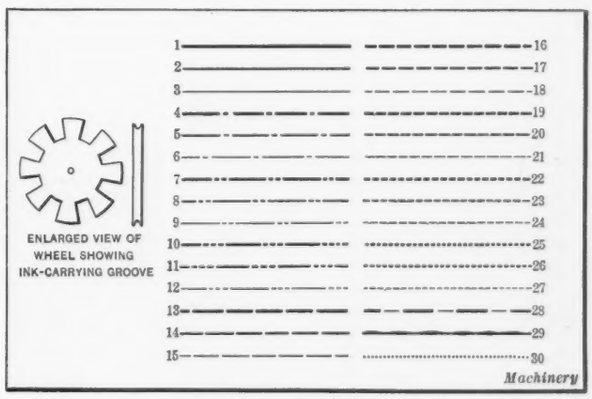
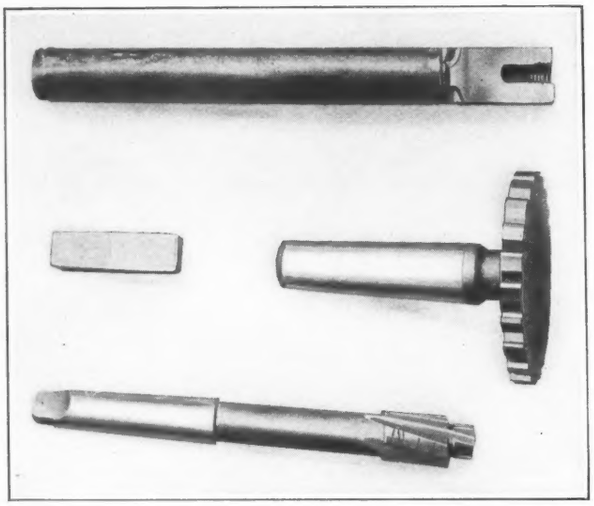


Fig. 3. Enlarged View of a Wheel and Examples of Different Lines for which Wheels are made



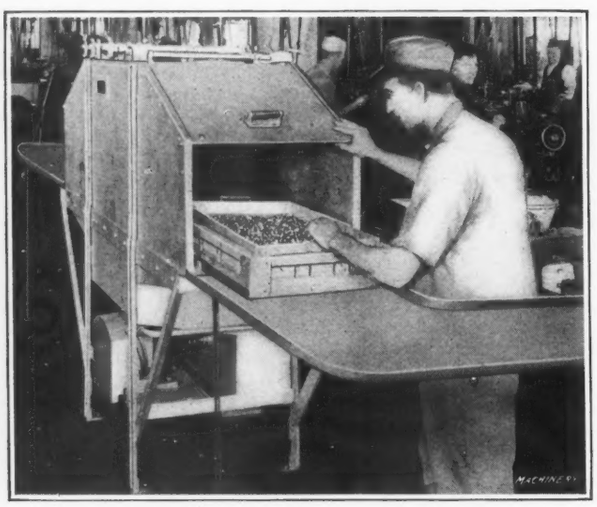
Ready Tool Co.'s Electrically Welded High-speed Steel Cutters with Carbon Steel Shanks

of steel in turning the shank down to the required dimensions. In addition, the labor cost of doing this work is often a substantial item. In manufacturing such tools the Ready Tool Co. is making the cutter-head of high-speed steel and the shank of low carbon steel, the two members of the tool being electrically welded together. In this way the double advantage of a lower cost for material and a reduction in the manufacturing expense is secured.

It is stated that tests which have been conducted to determine the strength of welds made by this company's process, have shown them to be of uniform strength throughout. Such tests have also appeared to show that the steel is as strong at the weld as at other sections. When so desired, this company is prepared to weld high-speed steel cutter-heads onto carbon steel shanks and anneal the welded tools, after which they are shipped to the user's plant to be machined and finished.

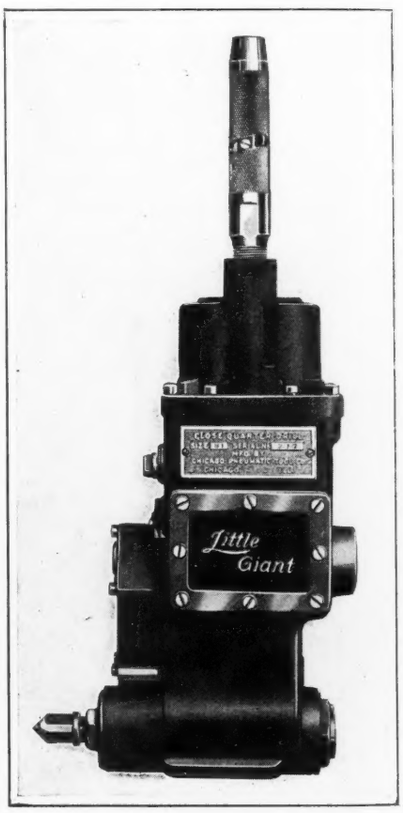
NIVIN METAL PARTS WASHING MACHINE

The Nivin Mfg. Co., Inc., 840 Larrabee St., Chicago, Ill., is now manufacturing a metal parts washing machine which is especially adapted for use in cleansing the product of automatic screw machines and work of a like nature. Particular attention is called to the fact that instead of immersing the metal parts in water, the wash water or bath is brought up to the work, and the parts are held stationary during the washing operation. The latter is a particularly important feature in the case of automatic screw machine products which have very delicate edges and fine threads. Such parts cannot be tumbled about or jammed against one another, as such action would result in seriously damaging the work. This machine is adapted for use in cleaning pieces ranging in size from small watch parts up to fairly large castings. The work is placed in wire mesh racks and run into the machine, after which it is merely necessary to push a button to start the washing operation. There are four nozzles above and four beneath from which revolving torrents of water swirl against the work in such a way that the most minute crevices are reached and thoroughly cleaned. The water is delivered from these nozzles by pressure developed from a motor-driven centrifugal pump so that it is independent of the pressure under which water is delivered to the plant. Any kind of washing compound can be used with this machine, and attention is called to the fact that much of the thoroughness with which this equipment accomplishes the desired result is due to the force and uniformity with which the fluid is delivered to all parts of the work.



Metal Parts Washing Machine built by the Nivin Mfg. Co.

In cases where a rinse is desired, the machine may be equipped to deliver water both from above and beneath in the same way that the washing solution is handled. The rinsing process is optional and under control of the operator. Metal parts may be retained in the washing chamber of the machine for as long or as short a period as desired, which is a convenient feature, because some classes of work require a longer period of washing than others. Where so desired, the water or solution in the tank of the machine can be heated either by steam or by gas. For this purpose a simple attachment is located beneath the tank, and although it is not generally used it may prove valuable for employment in cases where the nature of the work or other conditions make it difficult to secure a satisfactory result with cold water or a cold washing solution. In working out the design of this washing machine, care has been taken to simplify the construction and method of operation as far as possible. The main parts comprise a tank, washing chamber, nozzles for delivering the washing fluid and rinse water, a centrifugal pump and driving motor, and steam or gas connections to provide for heating the contents of the tank. As a result of the simplicity of design, the cost of repairs is reduced and the machine may be operated by an unskilled workman.



"Little Giant" Corner Drill manufactured by the Chicago Pneumatic Tool Co.

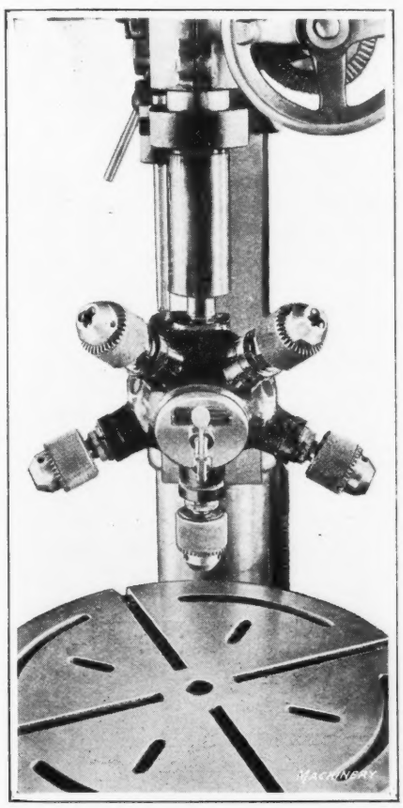
CHICAGO PNEUMATIC "LITTLE GIANT" CORNER DRILLS

The "Little Giant" corner or close quarters drill, manufactured by the Chicago Pneumatic Tool Co., 1060 Fisher

Bldg., Chicago, Ill., was designed to overcome the objection arising from the intermittent action of ratchet levers in the rotation of a drill spindle. Steady uninterrupted revolution of this drill spindle is accomplished by means of a train of gears retaining all the advantages of the ratchet type and permitting the drill to be used in the same narrow space, within 1 7/16 inch of the end wall or corner. Power of the motor is transmitted to the spindle without vibration, resulting in a steady, even pull with minimum wear and tear on the machine itself. Stub tooth gears are employed, and the special alloy steel used in these gears makes them practically indestructible.

SPAFFORD TURRET DRILL HEAD

In the accompanying illustration there is shown the latest type of "Fortin" five-spindle turret drill head as made by the Spafford Tool Works, 10 Hoadley Place, Hartford, Conn., for attachment to large-sized drilling machines. The demand for a small-sized turret drill head to be used on large drilling machines led to the development of this head which is built in two styles of various sizes. As designed for use on smaller machines, the head clamps directly to the sleeve. This new method of attachment allows the head to be used on drilling machines of any size or make. As shown in the accompanying illustration, the driving arbor fits into the spindle of the drilling machine while a separate piece is clamped to the sleeve with an adjustable rod connecting it to the head. This prevents the head from revolving and also from falling out of the spindle in case vibration should loosen it. Indexing is accomplished by pressing the lever in front and revolving the turret either way while the machine is in operation, to bring the tool to be used into the working position, the other spindles remaining idle.



"Fortin" Five-spindle Turret Drill Head built by the Spafford Tool Works

NEW MACHINERY AND TOOLS NOTES

Bench Lathe: Precision Lathe & Grinder Co., 128-130 Opera Place, Cincinnati, Ohio. A No. 3 precision bench lathe which is of similiar design to the Nos. 1 and 2 machines of this company's manufacture. The chief difference is that the bed is somewhat longer.

Thread Lead Testing Device: Geometric Tool Co., New Haven, Conn. A thread lead testing device which is equipped with a dial test indicator having two circles of graduations. The inner series reads to 0.001 inch and the outer to 0.01 millimeter. Consequently, the lead of either English or metric threads may be measured.

Shell Turning Lathes: R. M. Eddy Foundry Co., Chicago, Ill. A line of lathes adapted for the performance of various operations in machining 9.5-inch shells. The principal difference in design of the machines included in this line is that the carriage construction is made suitable for the particular operation which is to be performed by the machine.

Punching and Shearing Machine: J. J. McCabe Punch & Shear Co., 149 Broadway, New York City. A heavy pattern punching and shearing machine which is made in two sizes, having throats 36 and 50 inches deep, respectively. These machines are designed for use in shipyards and shops engaged in the manufacture of steel cars, boilers, railroad equipment, etc. They are also suitable for use in structural steel shops.

Motor-driven Lathe: Sebastian Lathe Co., Cincinnati, Ohio. A 10-inch motor-driven lathe which is of quite similar design to the lathe of this company's manufacture described in the October number of MACHINERY. The difference consists of the application of a motor mounted on a bracket at the back of the machine from which power is transmitted to a countershaft on the machine and thence by belt to the three-step cone pulley.

Locator: National Tool Engineering Co., Indianapolis, Ind. A device designed for use in drilling or boring holes in accurate relation to each other without requiring time to be spent in performing such operations by the "button" method. The device consists of a double cross-slide, saddle, and table. This equipment is said to be accurately constructed and provided with means of securely clamping it to the table of the machine on which the locator is to be used.

Metal Band-saw Machine: E. C. Atkins & Co., Inc., Indianapolis, Ind. A No. 3 metal-cutting band-saw machine which is claimed to have a capacity for performing from two to three times as much work as an average hacksaw machine, a further claim being made that the band saw will equal, if not exceed, the speed of cutting of a circular saw. The band-saw blades are much thinner than those of circular saws, so that a substantial economy is effected in cutting expensive material.

Tool Grinding Machine: Valley City Machine Works, Grand Rapids, Mich. A No. 16 wet tool grinding machine. A No. 17 machine of similar design is also made, which has the right-hand end of the spindle extended to provide for carrying a wheel for dry grinding The water pan contained in the column of the machine is hinged at the back and may be swung out. A plug is provided by which the tank may be drained. The tank and pump assembly may be entirely removed by withdrawing the hinge pin.

Inverted Drilling Machine: Wolverine Caster Co., Traverse City, Mich. A bench type of drilling machine in which the relative positions of the work and drill are reversed, thereby allowing chips to clear from the hole by gravity. An automatic weight feed is provided, which may be adjusted according to the size of drill which is being used. The machine has a capacity for handling drills up to ⅜ inch in diameter. The work-holding chuck is provided with jaws which open automatically, thus greatly facilitating production.

Sensitive Drilling Machine: Caulkins-Carpenter Co., 564 W. Randolph St., Chicago, Ill. A high-speed sensitive drilling machine designed in such a way that time is saved in clamping and removing the work, and in feeding the tool to the work. A foot lever at the right-hand side of the machine is so arranged that a slight movement clamps the work while continued movement feeds the drill to the work. When the proper depth has been reached the spindle is automatically tripped and returned to the starting point and the work is ejected.

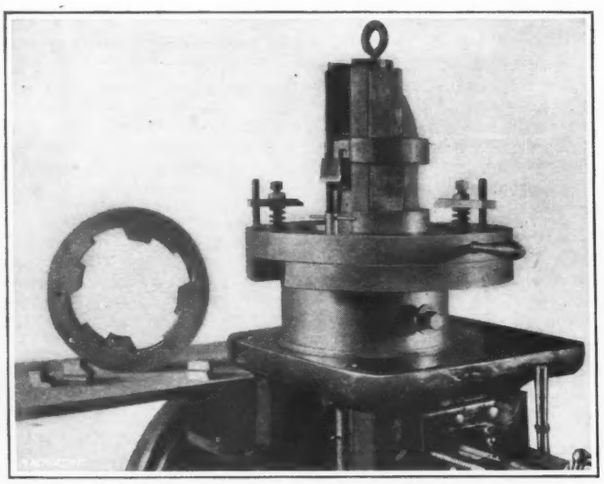
Automatic Bevel Gear Planing Machine: Gleason Works, Rochester, N. Y. This company is now building a 25-inch automatic bevel gear planing machine which is of the two-tool generating type. Those who have occasion to produce bevel gears of considerable size will be interested in this machine, which is said to be the first equipment, built for the general market, which will generate the teeth of bevel gears of one diametral pitch on a production basis. This is the maximum capacity of the machine, and it will produce heavy gears with such accuracy that they work smoothly and quietly.

* * *

The Supreme Court of Minnesota has ruled that a person called by a teamster to his assistance in an emergency becomes for the time being an employe of the teamster's employer, who becomes liable, under the Workmen's Compensation Law, for any injury that may be sustained by him in rendering the assistance requested.

MACHINING HOWITZER BREECH BUSHINGS

In the accompanying illustration there is shown an equipment recently built by Mitts & Merrill, of Saginaw, Mich., for performing a difficult machining operation in the plant of the Four Lakes Ordnance Co. of Madison, Wis. It is used in machining howitzer breech bushings on a Mitts & Merrill No. 5 Giant keyseater. The bushing is fastened to an index



Attachment used on No. 5 Giant Keyseater for machining Howitzer Breech Bushings

plate. Special formed cutters are used, which are made of the proper height so that by employing a series of cutters and spacing the keyseats with four series of index holes, the bushings are completed without the necessity of measuring. The cutters are simply inserted in a tool-bar which is fed up against a stop, and each cutter works to exactly the required depth.

* * *

NEW YORK JOINT MEETING OF ENGINEERING SOCIETIES

At the joint meeting of the New York members of the American Society of Mechanical Engineers, the American Society of Civil Engineers and the American Institute of Mining Engineers, to which were also invited the members of the American Institute of Electrical Engineers and of the Society of Automotive Engineers, held in the Engineering Societies' Building, 29 West 39th Street, New York City, November 20, an address on the demand for steel and the conservation of steel was given by Albert C. Ritchie of the War Industries Board, who told of America's part in supplying steel for the war needs of this country and the Allies and predicted a heavy demand from Europe for steel for reconstruction purposes. Encouragement would also be given to the railroads and public utilities' corporations in the United States to put their properties in good condition which would also require large quantities of steel. Mr. Ritchie pointed out that the restrictions on the industries would be removed just as rapidly as possible and that the Priority Board would exercise its functions with regard to government orders only. It was also stated that it has been estimated that the price-fixing policy adopted by the War Industries Board with regard to steel has saved the Government $3,000,000,000.

An address was also made by Captain P. E. Dulleux of the French High Commission in the United States. Captain Dulleux pointed out that probably eighty per cent of the steel producing plants of France had been destroyed during the war in the territories occupied by the Germans. The destruction was not wilful malice in all cases, but in many instances the machinery had been broken up and removed merely to furnish scrap metal for the steel industries in Germany, where the lack of raw materials was very severely felt. It is believed that the immediate demands of France for steel will amount to 8,000,000 tons, practically all of which must be furnished by the United States. The speaker stated, however, that with Alsace-Lorraine back in the possession of France, within a few years it was likely that France would be an active competitor of the United States in the European steel market.

An address relating to the comparative uses of reinforced concrete and steel in building operations and for various other purposes was given by Julius Kahn of Youngstown, Ohio, who outlined in a general way the possibilities of the use of concrete and the advantages gained thereby.

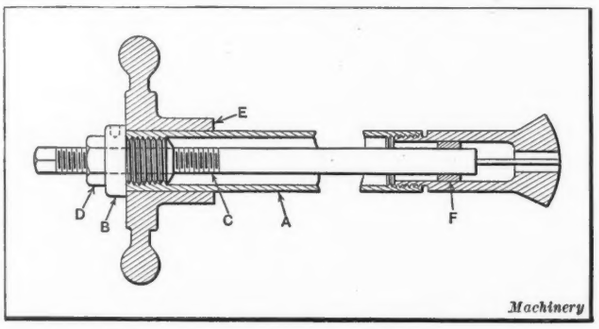
* * *

STOP FOR SPRING COLLET

BY DONALD A. BAKER

On page 69 of the September number of MACHINERY there appeared a description of a stop to be used in connection with bench or engine lathe spring collets. While the device described will locate work with sufficient accuracy to meet ordinary requirements, it would not be accurate enough where the length of the pieces must be finished within close limits of accuracy. The slight variation that would be experienced in using this stop is due to the fact that the chuck would not be drawn back into the lathe spindle an equal amount each time it was tightened unless the work were of exactly uniform diameter and even tension were exerted on the chuck each time. Since it is almost impossible to obtain these conditions, it will be seen that slight variations in the length of the work are likely to occur, as the stop is a part of the chuck and moves with it.

The device shown in the accompanying illustration is positive. It consists of a regular draw-back spindle *A*, keyed at the rear end to a collar on handwheel *E*. A fine-pitch thread is cut on the inside, into which the shouldered collar *B* is screwed. The collar also has a thread cut on the inside, for the passage of the threaded rod *C*, the end of which extends forward into the spring collet, forming a stop for the work. The end of the rod is supported within the collet by a collar *F* which is pressed onto the rod, as shown, and which is a sliding fit inside the spring collet. This collar prevents the end of the rod *C* from whipping, thus retaining its alignment with the spindle. A lock-nut *D* retains the position of the stop after the desired adjustment has been



Stop for Use in Connection with Spring Collets

made. It will be noticed that the location of this device is controlled by the face of the draw-back spindle collar *E*, which rests solidly against the end of the lathe spindle, so that when the adjustment is once made, the stop *C* holds a fixed relation to the spindle, irrespective of the distance the chuck draws back into the spindle.

* * *

The admirable French spirit that has made it possible for France during four years to keep the enemy at bay, until at last the day of triumph arrived, is well evidenced by a letter of inquiry from a French firm sent to Frank D. Chase, Inc., Industrial Engineers, Chicago, Ill., from which the following is quoted: "We are from the invaded country and are already studying the building of a large stove foundry to be built in the Ardennes as soon as, with America's great effort and sacrifice, we regain that country."

INFLUENCE OF TIME ON VARIATION OF HARDENED STEEL GAGES

BY CHARLES ELDRIDGE

The effect that the internal stresses developed in hardening will have on the size of steel gages is not easily determined because of the time element. However, the writer recently was able to learn the variation in the size of fifteen accurate size blocks he made sixteen years ago. These blocks were made of the best tool steel then available and varied, by sixteenths of an inch, from ⅛ to 1 inch in size. The ⅝- by 1-inch stock of which they were made was planed to size on the shaper, the blocks cut off in the milling machine, and their ends carefully planed, allowing 0.0010 inch for finishing by grinding. In hardening, the blocks were brought to an even red heat in a charcoal fire and quenched in brine. They were then heated just enough to take off the stress, or as the blacksmiths term this procedure brought to a "sizzling heat," which while not great enough to impart a light straw color readily evaporates a drop of water. They were then rough-ground on two surfaces only, as they were to be single dimension blocks; thus four surfaces were left untouched as they came from the fire. After rough-grinding, the blocks were laid on a window sill to season for a period of six months, during which time they were exposed to sunlight part of the day. As a result, during the seasoning period, they expanded and contracted approximately 182 times. Perhaps some of the present-day toolmakers will smile as they read of this procedure, but it should be borne in mind that the journeymen toolmakers a quarter of a century ago knew little concerning the heat-treatment of steel as the term is understood today, and had to get the best results possible by following natural methods.

After seasoning, the blocks were carefully ground to within 0.0003 inch of the size desired, this amount being left for lapping. They were held in a specially designed fixture and finished by spot-grinding; that is, they were passed by hand under a grinding wheel, the fixture bearing on a flat cast-iron plate placed in the platen of the surface grinder. Spot-grinding, if it is done properly, is productive of very accurate results. The blocks were then lapped to size on a cast-iron plate with carefully washed flour emery. After they were brought to the temperature of the room by being washed and cooled in gasoline, they were calipered with a comparatively new micrometer that had been carefully tested and, further to insure accuracy, were tested for size by a fellow-toolmaker who had the reputation of being the closest workman in the shop. When finished, the blocks were considered to be as accurate as two men could measure with micrometers graduated to read to ten-thousandths. Of course, it is not claimed that they were as accurate as the famous Swedish gages, but the variations were less than 0.0001 inch.

VARIATION IN SIZE, DUE TO INTERNAL STRESSES, OF HARDENED STEEL GAGES MADE SIXTEEN YEARS AGO

Size of Block, Inch	Variation in Size, Inch	Size of Block, Inch	Variation in Size, Inch	Size of Block, Inch	Variation in Size, Inch
1/8	0.0002	7/16	0.0003	3/4	0.0002
3/16	0.0001	1/2	0.0002	13/16	0.0000
1/4	0.0003	9/16	0.0000	7/8	0.0001
5/16	0.0000	5/8	0.0000	15/16	0.0001
3/8	0.0002	11/16	0.0001	1	0.0001

The blocks were used for six years in ordinary tool-room practice, for gaging slots, setting jig buttons, etc., and occasionally for setting tools in the planer or shaper. They have not been used for ten years, however, as the writer left the shop to engage in other work. Recently the blocks were calipered, when it was found that some of them were over size to a considerable extent, as the accompanying table shows. Why some of the blocks showed no variation and why the ¼-inch and 7/16-inch blocks were increased 0.0003 inch the writer is at a loss to say. The whole variation amounts to 0.0019 inch, and dividing this amount by 15, the number of blocks, the average variation carried out to ten places is 0.0001266666 inch.

The writer used every possible precaution in the making of the blocks to insure accuracy, and offers the following conclusions regarding molecular adjustment in hardened tool steel:

1. Reheating a piece that has just been hardened to a sizzling heat will not permanently arrange the molecules of which a piece of steel is composed, although this procedure is known to relieve stresses set up in quenching.

2. Exposing hardened pieces to alternate degrees of temperature for a period of six months is not sufficient to bring about permanent results in molecular adjustment.

3. Admitting that the molecules of which any body is composed are in constant motion, several years must elapse before the molecules of comparatively small pieces of hardened steel or the motion cycles are confined within fixed limits.

* * *

AIR-RIFLE WEDGE DIE

The article entitled "Air-rifle Wedge Die," appearing on page 251 of the November number, should have included the following paragraph, which the author wishes to add:

Some difficulty may be experienced at first in using this die, as the angle between the knock-out F and the punch I may be too slight, which would result in producing so much leverage on the knock-out that it would dent the metal before it is completely cut off. In order to increase the action in such a case, the angle at the back of the knock-out should be reduced to about 40 degrees with the face of the die, that is, the angle between the punch I and the knock-out F should be increased so that the action of the knock-out will be accelerated sufficiently to overcome this trouble. W. B. G.

* * *

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies' Building, New York City, December 3 to 6, 1918. On Tuesday evening, December 3, the presidential address will be given, followed by a reception. On Wednesday morning, December 4, there will be a business meeting covering amendments to the constitution, and reports of standing and special committees. At luncheon the same day there will be an address by Dr. George W. Kirchwey, formerly Dean of Columbia Law School, on "A Message from the Legal Profession." In the afternoon there will be three simultaneous sessions on Machine Shop Practice, on Refrigeration, and on Weights and Measures. At the machine shop session, papers will be presented on thread gages and on standards for large taper shanks and sockets. In the evening there will be a lecture on the achievements of naval engineering by William L. Cathcart, Lieutenant-Commander, U. S. N. R. F. Thursday morning, December 5, there will be a keynote session on the general subject of engineering of man power, with a number of papers and addresses, and in the afternoon, simultaneous sessions of the textile and gas-power sections. Thursday evening there will be motion pictures relating to the technical side of the war, and Friday morning, December 6, there will be simultaneous sessions relating to power plant engineering and general subjects.

* * *

CORRECTION

On page 254 of the November number of MACHINERY, a formula is given as follows:

$$W = \sqrt{R^2 - (R - D)^2}$$

This formula should read:

$$W = \sqrt{R^2 - (R - H)^2}$$

in which H is the height of the segment.

CUTTING LARGE SPIRAL BEVEL GEARS FOR EXPERIMENTAL PURPOSES

BY A. L. STEWART

The Gleason Works, of Rochester, N. Y., recently completed some experimental work in cutting and testing spiral bevel gears of large diameter. In order to do this, one of their standard 54-inch bevel gear planers was especially equipped to give the necessary additional motion. Fig. 1 shows the machine in the process of cutting a large spiral bevel gear which is shown in mesh with a pinion in Fig. 2.

The spiral curve was obtained by oscillating the gear blank in unison with the stroke of the tool, the work-spindle and the tool-slide being geared together. The curve resulting from this arrangement is a true Archimedes spiral. A variable-speed reversing motor seen in Fig. 1 was used for the main drive, the controlling switch located on the turret being tripped by dogs on the tool-slide at each end of the stroke. A rack and pinion drive for the tool-slide was adopted instead of the usual crank-plate in order to give a uniform motion. A specially constructed tool-block was used to allow the tool to be swiveled to the angle of spiral. The drive for the feed mechanism was taken from a reversing shaft by two ratchet wheels and silent pawls so as to give a motion in one direction, and a separate motor was used for the index drive. The index movement and the rolling motion of the blank in time with the tool stroke were both obtained through the same worm and worm-wheel. A differential was used in the index bracket for this purpose, the driven member of the differential being connected to the index worm through index change-gears.

The first gear and pinion cut on the machine are shown in Fig. 2. This combination is 16 and 96 teeth of 2½ diametral pitch, the width of face is 4¼ inches and the outside diameter is 38.532 inches. This would represent a typical boring mill table drive. The angle of spiral at the center of the face is 20 degrees 36 minutes, giving a spiral lead equal to one and one-half times the circular pitch. The gears are the same as to pitch, face and root angles and pitch, and outside diameter as straight-tooth gears. The usual forms were used so that the cross-sectional shape of the tooth at any point taken in a plane at right angles to a cone line, is the same as for a straight-tooth gear.

When run on a testing machine under brake load as shown in Fig. 2, the gears gave a very smooth action with a bearing for the full length of the tooth. While the machine used for this work was only altered temporarily and the Gleason Works are not offering it to the trade, the demonstration has proved the practicability of cutting bevel gears of this size with spiral teeth which provide means of transmitting great power through gears which operate smoothly and silently. This latter characteristic probably needed no proof since it has already been well established by spiral bevel gears of smaller size and by helical and herringbone spur gears.

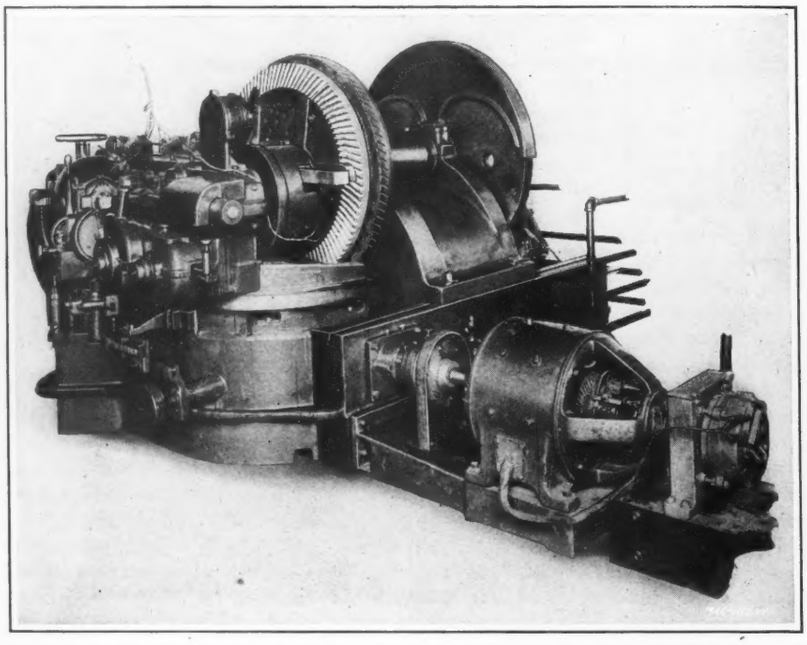


Fig. 1. Fifty-four-inch Bevel Gear Planer as modified to cut Spiral Bevel Gears

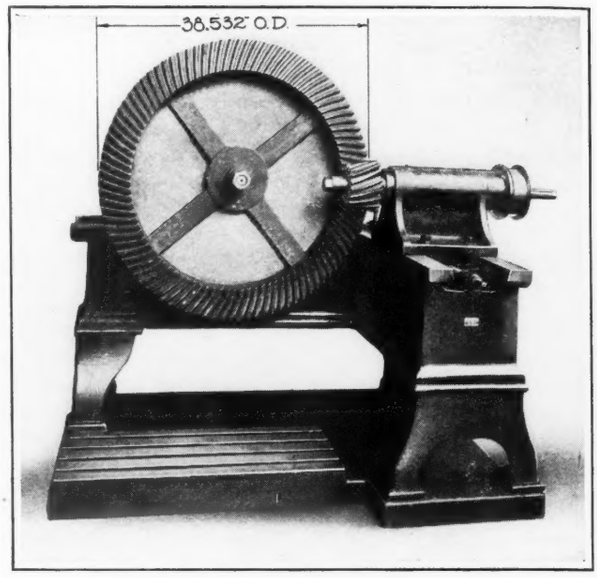


Fig. 2. Spiral Bevel Boring Mill Table Gears mounted on Testing Machine

* * *

MODIFICATIONS OF INDUSTRIAL RESTRICTIONS

The War Industries Board immediately upon the declaration of the armistice began to modify the restrictions whereby it has controlled American industries in the interest of the nation's war program. It will be the policy of the board to gradually lift various restrictions and curtailment with a view to bringing about as promptly as possible a return to normal conditions. In the modification of the curtailment imposed on the manufacture of certain commodities, the board has adopted the method of announcing from time to time lists of commodities in respect to which the curtailments are to be modified. The first announcements related to building construction, giving permission to construct certain types and classes of buildings without having to apply to the War Industries Board for permission. Complete details relating to this subject may be obtained by applying to the War Industries Board, Washington, D. C.

Restrictions have also been removed from certain manufacturing industries as regards the production or consumption of, and materials for, certain articles. In this case the return to normal conditions will be gradual, and for the time being 50 per cent of the restriction will remain in force; in other words, if an industry for the last four months of 1918 has been curtailed 25 per cent such curtailment is now changed to 12½ per cent. These rulings apply to the following manufactures in the machine-building and kindred fields: agricultural implements and farm operating equipment, including tractors; road machinery; sewing machines; boilers; electric fans and fan motors; and passenger automobiles. Certain restrictions relating to the dealing in raw materials and products of iron and steel have also been modified.

NEW METHOD OF COOLING GAS ENGINES

BY MARK MEREDITH

Hitherto the cooling of gas engines, except in the case of very small sizes, has been done by circulating water around the cylinders, and, in large engines, in the bodies of the piston and exhaust valve as well. The necessity for external water-cooling is one of the disadvantages under which the gas engine has labored and which has retarded its development in larger sizes. When these difficulties and their causes have been clearly stated, it seems fairly obvious that they can be overcome by applying the cooling medium on the inside of the cylinder instead of on the outer surface. If water can be injected internally against the surfaces to be cooled, the heat is removed on that side of the metal on which it is generated, and therefore there is no heat-flow through the metal and no difference of temperature between the inner and outer surfaces. The water may be distributed by means of jets, so that each part receives it in proportion to the rate at which it receives heat from the hot gases. Thus the engine can be maintained at substantially the same temperature all over, and the stresses due to unequal heating may be eliminated. A simple single-walled casting can be used for the cylinder, resulting in a great saving in weight and cost and in improved reliability on account of the eliminating of casting stresses. The arrangements for cooling the piston, which are necessary in large engines, can be dispensed with, which is a point of great importance, because these arrangements, besides being costly, frequently give trouble, and their failure may easily result in wrecking the engine. Finally, preignitions are entirely prevented.

In the method of internal injection, cold water is injected through a hollow casting projecting into the combustion chamber and provided with a number of holes or small nozzles about 1/32 inch in diameter. The jets so formed are comparatively coarse, so that even when projected into the flame the water reaches the part of the wall against which it is directed, but with little evaporation on the way. The jets are directed to all parts of the surface of the combustion chamber and against the face of the piston.

Professor Hopkinson's Experiments

When Professor Hopkinson, who has undertaken much research work on gas engines first began to consider the use of internal injection as a means of cooling, the difficulties of corrosion and lubrication seemed to be an insuperable bar until it occurred to him that they could probably be overcome by the simple device of regulating the amount of water injected in such a way that the temperature of the entire engine is kept well above 100 degrees C. Under such conditions (which, of course, are only rendered possible by the absence of all external water-cooling) every drop of injected water is evaporated when it reaches the walls, and no liquid can therefore accumulate. That corrosion may be completely prevented in this way has been proved by actual trials, of which particulars were given.

The practical application of this system of cooling has been much facilitated by a discovery made by Professor Hopkinson soon after he began experimenting with it. It was well known that the rate of heat-flow from the gas into the metal is far more rapid at, and soon after, the moment of ignition than at any other time. It seemed likely from these experiments that for practical purposes the heat-flow into the barrel of the cylinder during the last three-fourths of the expansion stroke might be so small, compared with that in the first period, that direct cooling of this portion of the cylinder could be dispensed with altogether. This anticipation has been found to be correct. It is sufficient to inject water onto the surface of the combustion chamber and the head of the piston only, the whole of the cooling of the barrel being effected by conduction into the piston, which is itself kept cool by the projection of water onto the head when it is near the in-center. By taking advantage of this fact the application of water is confined to places where it can do no harm, none falling on the sliding surfaces. This is a point of some importance if the water contains much dissolved matter.

Practical Tests of New Method

In order to put these ideas to a practical test, a Crossley engine, 11½ inches in diameter by 21 inches stroke, rated at 40 B.H.P., operating on coal gas at 180 revolutions per minute, was fitted with a new cylinder consisting of a plain barrel without any water jacket. The valve motions were retained, and the valves and the shape of the combustion chamber were the same, the only change being the removal of all external water-cooling.

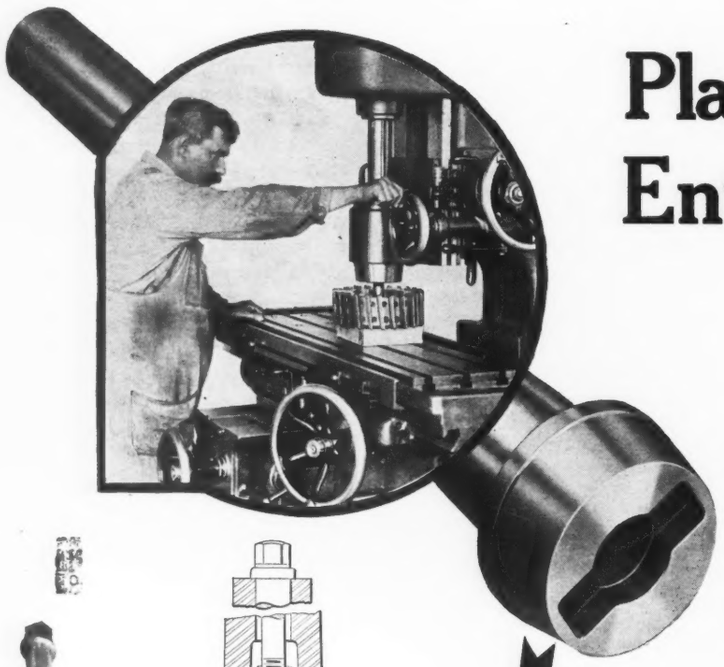
Immediately after erection with the new cylinder, the engine was run continuously for 120 hours on an electrical load with coal gas. Continuous observation was kept of the gas consumption and of the load. The engine developed during this period 43 B.H.P., on the average, and ran very smoothly and steadily. The average mean effective pressure was 101 pounds per square inch. When jacketed, the engine would not develop more than 40 B.H.P. continuously without overheating, and mixtures giving a mean pressure of more than 100 pounds per square inch produced excessive maximum pressures of over 500 pounds, with violent thumping explosions. The reduction in maximum pressures, under these circumstances, by water-injection was over 100 pounds per square inch, and the effect was very marked, the explosion becoming inaudible.

The quantity of water used on this trial was, on the average, 102 pounds per hour, equivalent to 2.4 pounds per B.H.P. hour. The temperature of the engine varied from 150 degrees to 180 degrees C. No water was visible on the piston or the spindles of the valves, and when the engine was stopped at the end of the trial the inside of the combustion chamber was found to be perfectly dry. When the engine was jacketed and giving the same power for short periods, the jacket water removed about 67,000 B.T.U. per hour, which would be sufficient to evaporate 108 pounds of water at a temperature of 20 degrees C. under atmospheric pressure. The agreement between the available heat and the amount of water evaporated is satisfactory, such difference as there is being accounted for partly by greater radiation loss due to the higher temperature of the engine, and partly by the reduction in flame temperature produced by the steam, which somewhat reduces the total amount of heat passing into the walls.

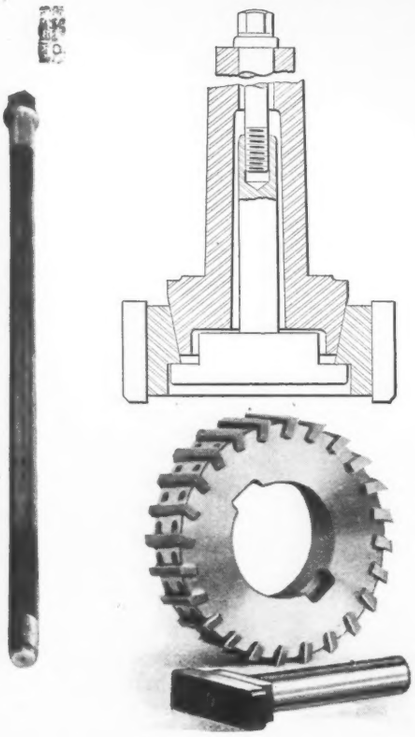
Effect on Fuel Consumption

The engine consumed in this trial 15 cubic feet of Cambridge coal gas per B.H.P. hour reckoned at atmospheric temperature and pressure. This is approximately the same as it burned when developing the same power for short periods when jacketed. Tests at other loads have shown that with a weak mixture the gas consumption is slightly increased by the water injection, but with very strong mixtures it is a trifle less. The difference, however, does not exceed 5 per cent either way, and on the average it may be said that the economy is unaffected by the use of this method of cooling. Indicator diagrams taken in this trial, compared with similar diagrams taken from the jacketed engine, show that the reduction in maximum pressure is counterbalanced by a slightly raised expansion line. The pressure is better sustained, partly by the formation of the steam and partly by the reduced loss of heat, with the result that the diagram is "fuller" and less "peaky."

After the trial just described, the engine was applied to the driving of a dynamo in a factory engine room. Its speed was increased from 100 to 190 revolutions per minute. It was left in the hands of the ordinary engine-room staff for several weeks, and was worked continuously for long periods of time at excessive loads. During this period it developed at times 50 B.H.P. with coal gas for several hours together—an increase of 25 per cent on the maximum continuous load which it would carry when jacketed. Since then the engine has been brought to Cambridge, and is now engaged in regular service with a suction producer, driving the work-shops



Place Cutter on Enters Cutter, *Simple,*



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on Brown & Sharpe Milling Machines because of the taper-nose construction of the spindle. Method of attaching cutter is a time-saving feature on all types and especially advantageous on the vertical spindle machines. See diagram and description at left.

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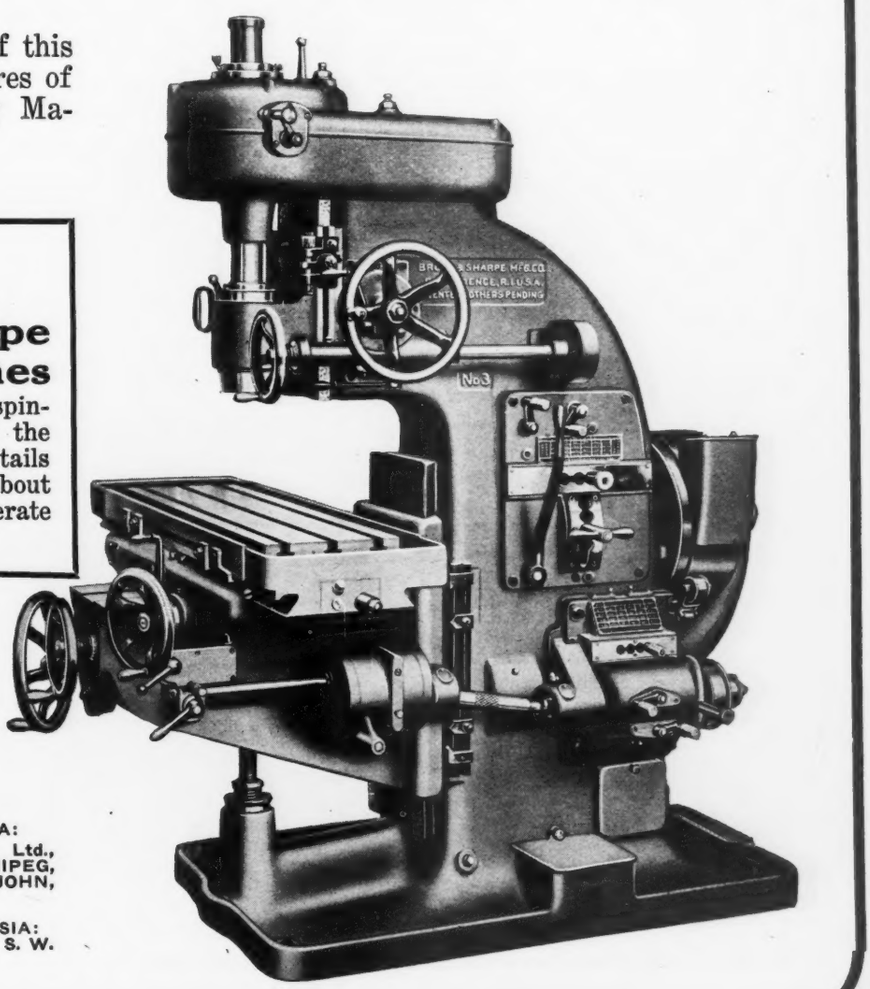

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R. L. Scrutton & Co., Ltd., Sydney, N. S. W.

and producing electric current for the engineering laboratory. It is left to itself like an ordinary gas engine, giving no trouble at all, and has now been in regular work for two years, the total time of running being 5000 hours.

Method Used to Control Cooling System

Anthracite coal is used in the producer, and this coal contains a considerable proportion of sulphur; yet there has been no trace of corrosion in the engine. The ordinary working temperature is between 120 degrees C. and 200 degrees C. In order to keep the temperature between these limits, some regulation of the water supply in accordance with the load is necessary. With a throttle governor it is only necessary to connect the gas supply and the water supply in such a way that the correct amount of water is delivered at all loads. In smaller engines it is important to make the whole thing automatic. For this purpose a simple form of thermostat has been designed which opens the by-pass valve if the temperature falls too low.

In order to minimize the inconvenience and to guard against any danger arising from failure of the water supply, the engine is provided with a fusible plug screwed into the wall of the combustion chamber. Should the temperature rise above about 200 degrees C. (quite a safe working temperature), the plug melts, and the noise of the escaping gases warns the attendant. From the nature of this method of cooling, it seemed almost certain that its effectiveness would be independent of the size of the engine. The truth of this anticipation has been proved by applying the method to the cooling of larger engines, one an engine of 18½ inches bore, giving 105 B.H.P., and the other a 1000-horsepower Oechelhauser engine of 36 inches bore. The trials of the large engine, which continued for a considerable time, proved beyond any question that the cooling by water injection, if applied in accordance with the principles enunciated, could be successfully used. They also showed, however, as might be expected, that for ordinary commercial use the cylinder must be properly designed with a view to the employment of this method of cooling. The most obvious point is that the cylinder must be a plain barrel without any jacket.

* * *

A valuable application of the motion picture principle is met with in the taking of moving microscopic images as they appear under the camera. An example of this application was recently exhibited at the convention of the American Society for Testing Materials at Atlantic City. The idea was applied to wrought iron. It is known that when a metal like wrought iron or steel is subjected to alternate stresses or shocks caused by repeated bendings or blows, the metal gradually weakens and finally breaks. It is further known that all such metal is composed of a mass of closely-lying crystals and that these bendings and blows have a tendency to distort these crystals, causing the ultimate result. With these facts in mind, a moving picture was taken and reproduced on the screen, showing the successive changes which take place in the structure of the metal when subjected to bending or hammering. In the test, the piece of iron was placed in a bending machine and the microscope attached just over the place where the metal was most affected and a camera was attached to the microscope. The effect, as recorded through the microscope and camera was remarkable, each minute change in the structure and crystals being accurately reproduced until the piece finally broke. The gradual formation of cracks was distinctly visible.

* * *

CONVENTION OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

It has been announced that the convention of the National Machine Tool Builders' Association which was to have been held November 7 and 8 but was postponed because of the epidemic of influenza, will be held at the Hotel Astor, December 10 and 11.

NEW BOOK ON ELECTRIC WELDING

ELECTRIC WELDING. By Douglas T. Hamilton and Erik Oberg. 294 pages, 6 by 9 inches; 213 illustrations. Published by The Industrial Press, 140-148 Lafayette Street, New York City. Price, $2.50.

This book is a comprehensive treatise on the practice followed in the application of the various resistance and arc welding processes, covering descriptions of the machines and apparatus used and the methods employed in manufacturing and repair work. Electric welding has become so important an art in the mechanical industries that a comprehensive treatise on this subject is needed in the trade. A special study has, therefore, been made by the authors of this work, who have been assisted by the experts in resistance and arc welding of some of the most prominent concerns in the United States engaged in this industry. Consultations with these experts have made it possible to obtain thoroughly up-to-date information embodying the latest developments and discoveries in the art. It is therefore believed that the book will prove especially useful to those who are already employing electric welding equipment, as well as to those who are contemplating its use. The book should also be of particular value to the students on the subject who desire to obtain authoritative information on the electric welding process.

In dealing with the subject, it has been divided into nine chapters, each covering a special phase of electric welding. In addition, there is an introductory chapter which deals briefly with the main principles and reviews the different systems of electric welding. The headings of the various chapters will indicate the ground covered: Electric Resistance Butt-welding; Special Butt-welding Machines and Processes; Electric Spot-welding; Seam-welding and Riveting; Percussion Welding; Electric Soldering; Principles of Electric Arc Welding; Applications of Electric Arc Welding; Welding Transformer Tanks by the Electric Arc.

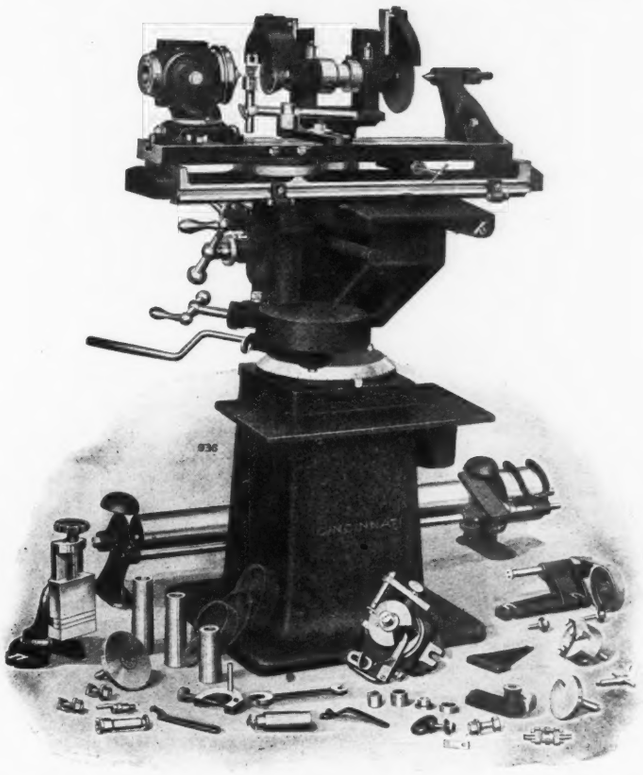
The methods are dealt with in considerable detail under each of these headings. For example, in the chapter on electric arc welding, the following subdivisions are treated: The Electric Arc; the Carbon Arc; the Metallic Arc; Polarity for Carbon Arc Welding; Polarity for Metallic Arc Welding; Combination of Metallic and Carbon Arcs; Carbon Electrodes; Metallic Electrodes; Current and Voltage for Carbon Arc; Current Required for Metallic Arc; Metals that can be Welded; Sheet Metal Welding; Preparing Work for Welding; Preheating; Equipment Required; Motor-generator Sets; Dynamotors; Switchboards; Operation of Welding Outfit; Electrode Holders and Cable; Striking Arc and Handling Electrodes; Protection of the Operator; Capacity of Outfits; Cost of Welding; Metallurgy of Electric Arc Welding; Strength of Welds; and Quality of Electric Welds. In addition, there are numerous examples of the applications of electric arc welding to both manufacturing and repair work. The resistance welding processes are dealt with in still greater detail, because these are used to an even larger extent for manufacturing work.

* * *

INTERNATIONAL COMMISSION'S REPORT ON THE METRIC SYSTEM

The United States Section of the International High Commission, of which Secretary McAdoo is chairman, has adopted the following resolution with regard to the metric system: The United States Section of the International High Commission having in view the present efforts to bring about the exclusive use of the metric system of weights and measures within the jurisdiction of the United States, resolves: (1) That in the opinion of the section, the adoption of that system would be productive of great advantage in the commercial relations of the United States with the other American Republics. (2) That the secretary of the section be directed to communicate a copy of this resolution to the chairman of the proper committees of the Senate and the House of Representatives.

CLEARANCE



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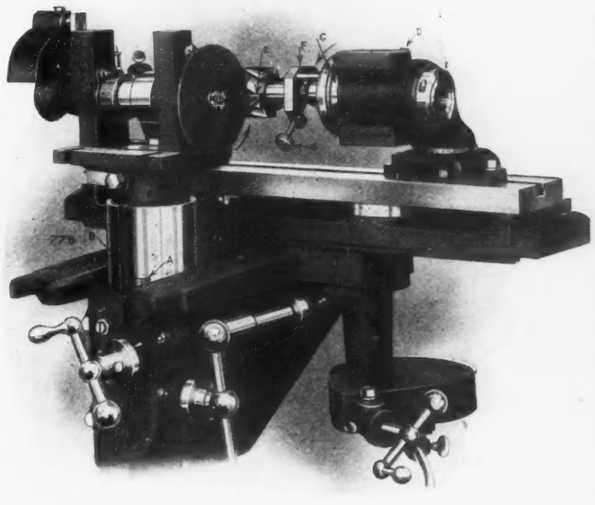

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PERSONALS

GEORGE C. SANFORD, formerly of the Elevator Supplies Co. and of the Otis Elevator Co., has been made superintendent of the Barber-Greene Co., Aurora, Ill.

J. D. Apgar formerly with Vandyck Churchill Co. of the New York territory, is now associated with the Machine Tool Engineering Co., 149 Broadway, New York City.

E. L. EVANS has been appointed superintendent of plant No. 1 of the Bound Brook Oil-less Bearing Co., Bound Brook, N. J. Mr. Evans was formerly chief inspector of that plant.

C. W. STEPHENS has been appointed manager of sales of the Detroit Twist Drill Co., Detroit, Mich., succeeding Nelson J. Smith who becomes assistant to the president, Muir B. Snow.

E. L. GARRIHAN, who for the past twenty years has been identified with the manufacturing and sales department of the Bethlehem Steel Corporation, has become manager of sales for the Tioga Steel & Iron Co. of Philadelphia.

F. E. SMITH, formerly of the engineering department of the Stephens-Adamson Mfg. Co., of the Granby Mining & Smelting Co., and the American Zinc & Chemical Co., has become chief engineer of the Barber-Greene Co., Aurora, Ill.

ROGER C. SULLIVAN was elected chairman of the board of directors of the Independent Pneumatic Tool Co., Chicago, Ill., and a member of the executive committee at a special meeting of the board, to fill vacancies caused by the death of John P. Hopkins. Mr. Sullivan was also appointed a director of the company.

CLARK W. PARKER and WYMAN C. PARKER have disposed of all their stock in the Parker Rust-proof Co. of America. Clark W. Parker has also resigned as director and is no longer connected with the corporation in any capacity. Their stock interest has been acquired by A. V. Foster of the firm of Spitzer, Rorick & Co., Toledo, Ohio.

I. H. Mills, who has been connected with the Westinghouse Electric & Mfg Co. of East Pittsburg, Pa., for the past twenty-three years, has resigned to become superintendent of the Sperry Gyroscope Co. of Brooklyn, N. Y. Mr. Mills began with the Westinghouse Co. as a machine operator, and finally became superintendent of the Small Industrial Motor Department.

JOHN BROOKS EMORY, formerly general superintendent of the Poole Engineering & Machine Co., Baltimore, Md., is now connected with the Morgan Engineering Co., Alliance, Ohio, in a similar capacity. Mr. Emory was previously with the Baltimore & Ohio Railroad, and upon leaving there became Superintendent of Motive Power with the Kansas City Southern Railroad, which position he resigned to become associated with the Poole Engineering & Machine Co. He is a graduate of Purdue University, and is well known in railroad, machinery, and foundry circles.

OBITUARIES

A. R. Gorsline, president of the Cochrane-Bly Co., Rochester, N. Y., died suddenly on November 25. A sketch of his life will be given in the January number of MACHINERY.

LIEUTENANT ANGUS DOUGLAS GRAY, M. C., of the 4th Canadian Machine Gun Company, died October 25 from pneumonia, aged twenty years. Lieutenant Gray joined the Canadian Expeditionary Forces in July, 1915, and was wounded in the battle of the Somme, July, 1916, and again in the battle of Fresnoy, May, 1917, at which time he received the military cross. He was transferred to the C. E. F. Reserves in January, 1918, and at that time became associated with the Gray Machine Tool Co., Inc., of Buffalo, N. Y., as vice-president and secretary.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC. REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly at New York, N. Y., for October 1, 1918.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the General Manager of MACHINERY and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Industrial Press	140-148 Lafayette St., New York
Editor, Erik Oberg	" " " " "
Managing Editor, None	
Business Managers { Alexander Luchars, President	" " " " "
Business Managers { Matthew J. O'Neill, Treasurer and General Manager	" " " " "

2. That the owners of 1 per cent or more of the total amount of stock are:

The Industrial Press	140-148 Lafayette St., New York
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
Erik Oberg	" " " " "
H. L. Ketchum	" " " " "
E. Y. Urban	" " " " "

3. That there are no bondholders, mortgagees, or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 26th day of September, 1918.

CHARLES J. MOREY,

(SEAL) Notary Public, New York County, No. 398.
New York Register, No. 10325.
(My commission expires March 30, 1920.)

COMING EVENTS

December 3-6—Annual meeting of the American Society of Mechanical Engineers at 29 W. 39th St., New York City.

December 10-11—Annual convention of the National Machine Tool Builders' Association, at Hotel Astor, New York City. Charles E. Hildreth, Worcester, Mass., general manager.

SOCIETIES, SCHOOLS AND COLLEGES

Carnegie Foundation for the Advancement of Teaching, 576 Fifth Ave., New York City. Bulletin 11, entitled "A Study of Engineering Education," prepared for the Joint Committee on Engineering Education of the National Engineering Societies, by Charles Riborg Mann. The bulletin is divided into three parts as follows: Part 1, Present Conditions; Part 2, Problems of Engineering Education; and Part 3, Suggested Solutions.

National Safety Council, Continental and Commercial Bank Bldg., Chicago, Ill., has published a calendar known as the "National Safety Council's 1919 Safety Calendar." It is a most original piece of work along this line and will have a special appeal at this time, because the calendar records in twelve pictures the career and ultimate fate of the world's greatest chance-taker—the Kaiser—containing in each of the twelve pictures an appropriate slogan applicable to industrial work. It is reasonable to expect that the calendar will prove most popular during the coming year. These calendars are sold at 25 cents each, with substantial reductions for quantity orders.

BOOKS AND PAMPHLETS

Standard Motor Transportation Guide. 60 pages, 5 by 8 inches. Published by D. Schubert, 2 Columbus Circle, New York City. Price, $1.

This book is intended for the use of manufacturers and others interested in motor truck transportation, and gives the distance of various cities in the states adjoining New York City from the latter point. In view of the fact that the motor truck seems to be destined to become an important factor in national transportation, the book should prove of considerable value.

General Science. By Herbert Brownell, B. Sc. 383 pages, 5½ by 8 inches; 118 illustrations. Published by P. Blakiston's Son & Co., 1012 Walnut St., Philadelphia, Pa. Price, $1.

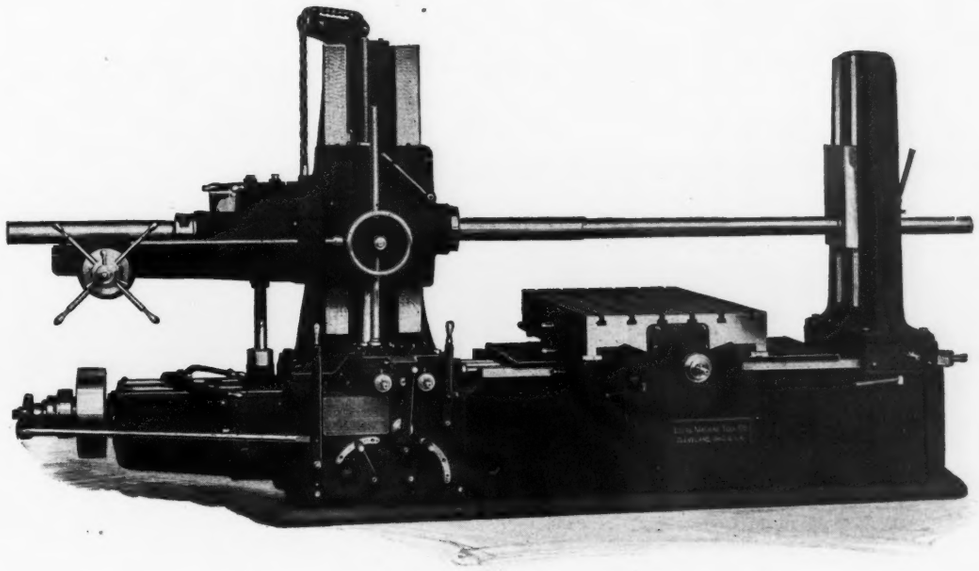
This is a book intended for schoolroom use in which the teachings of science in its application to every day life is made clear. Its discussions are designed to stimulate a desire on the part of pupils for the scientific knowledge that may be obtained from the study of high-school text books. Some of the many subjects treated are: Heat in Relation to the Human Body; The Atmosphere; Matter and Force; The Phenomena of Life; The Earth as a Planet; and Weather and Climate.

How to Handle and Develop Your Own Business. 142 pages, 5½ by 8½ inches. Published by A. W. Shaw Co., 461 Fourth Ave., New York City.

This book contains an outline of a great number of plans and methods that have been found actually useful in established undertakings for building up business. There are a number of business management plans and methods outlined in the book, each having been selected only after many similar plans had been discarded. It is stated in the preface of the book that several hundred plans and methods were carefully inspected to secure the number included in the book. One of the features of the work, therefore, is that it does not record a system used by one manufacturer or business house only, but contains a digested record of what is considered the best available information along the lines covered. The book is divided into nine chapters, as follows: How to Tone up Your Business; Simple but Effective Accounts and Records; Keeping the Books Clear of Bad Debts; How to Write Result-getting Letters; Making Your Advertising Hit Harder; Better Ways to Select and Train Your Assistants; More Effective Selling Methods; Office Methods that Cut "Red Tape"; How to Make Your Banker "See It Your Way." Forty illustrations and charts visualize the information contained.

The Internal Gear. 94 pages, 6 by 9 inches; 58 illustrations. Published by the Fellows Gear Shaper Co., Springfield, Vt.

This is a book on the design and application of internal gears, which gives a simple but practical analysis of the comparative tooth action of internal gear-teeth, together with directions for cutting, and a representative collection of satisfactory applications of the internal gear for speed reduction mechanisms, including drives for truck axles, drives for air drills, electric hoists and similar classes of work. The field covered is indicated by the chapter headings which are as follows: Definition and Advantages of the Internal Gear; Design of Internal Gears; Graphical Analysis of Tooth Action of Internal Spur Gear; Internal Helical Gear Design; Cutting Internal Gears; A Variety of Applications of the Internal Gear. The development of various forms of reduction gear drives where compactness of design is an essential factor, has brought the internal gear into prominence and the data given in this book which is the first complete treatise to be published on this subject, should be of great value to designers and engineers as it is based on the extensive experience of the Fellows Gear Shaper Co. in designing machinery for



Do you keep a record of the performance of every tool in your shop; how much work it does; how good work it does; how long it takes to "break in" a new man on the machine; how much it stands idle for repairs, and how much the repairs cost? If you do, you are just the kind of a customer we want for the

"PRECISION"

BORING, DRILLING AND MILLING MACHINE

THE

ORIGINAL "LUCAS TYPE"

Power feeds in every direction. QUICK POWER RETURN to every feed. THE SAME LEVER FOR ALL.

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF CLEVELAND, O., U.S.A.

cutting all types of spur and helical internal gears. It contains much useful information required in the designing of spur and helical internal gear drives, and the tables for quickly determining the standard inside diameters and base diameters of internal gears having 14½-degree involute teeth, and for those having 20-degree stub teeth are conveniently arranged. Formulas for calculating the elements of internal spur gears are given, together with other useful formulas for determining the elements of helical and herringbone gears.

NEW CATALOGUES AND CIRCULARS

AB Flush Valve Co., Piqua, Ohio. Circular of the "KasKade" direct-pressure flush valve—a corrode-resisting all-metal valve.

Ilg Electric Ventilating Co., Whiting and Wells Sts., Chicago, Ill. Circular descriptive of the Ilgair unit system of heating.

Gisholt Machine Co., Madison, Wis. Folder PC2, advertising the "Periodograph," a machine for keeping a record of workmen's time.

J. C. Glenzer Co., Detroit, Mich. Circular containing information and price list for the "Utility" interchangeable counterbore and spotfacer.

National Acme Co., Cleveland, Ohio. "Namco" calendar for 1919, showing illustrations of the National-Acme automatic screw machines and turret lathes, and other products.

Edlund Machinery Co., Inc., Cortland, N. Y. Circular descriptive of the Edlund "Reliable" sensitive drilling machine and of the Edlund quick-operating milling machine vise.

Herman A. Holz, Metropolitan Tower, New York City. Bulletin of "Fahy" permeameters of the compensated and simplex types—instruments for the accurate and convenient determination of the magnetic properties of iron and steel.

H. Edsil Barr, Erie, Pa. Bulletin illustrating and describing the Barr pneumatic high-speed hammer, the purpose of which is to eliminate most of the hand work in doing all kinds of light tool dressing, forging, black-smithing, and similar work.

Coppus Engineering & Equipment Co., Worcester, Mass. Catalogue of the Coppus turbo blower for undergrate draft and other industrial purposes. The catalogue gives tables of dimensions, speed, pressure, and volume of air delivered.

Tate-Jones & Co., Inc., Pittsburg, Pa. Booklet entitled "Fuel Oil and Its Use," giving information concerning fuel oil, oil feeding, piping lay-outs, and burners, and including data on various types of oil burners, steam pumping systems, oil heaters, etc.

Cleveland Twist Drill Co., Cleveland, Ohio. Poster calendar for 1919 entitled "The Message from France." The calendar carries a preface written especially for it by Charles M. Schwab of the Emergency Fleet Corporation. Copies will be furnished free upon request.

National X-Ray Reflector Co., 235 W. Jackson Blvd., Chicago, Ill. Catalogue 21 describing the direct-lighting reflectors produced by this company. To cooperate with the Government's request to conserve paper this catalogue will not be sent out generally but only upon request.

Gisholt Machine Co., Madison, Wis. Circular entitled "How to Make High-priced High-speed Steel Go Further," containing information on Gisholt tool-holders by means of which high-speed steel tools can be utilized down to the last inch or so. The circular gives complete dimensions and prices.

Cleveland Punch & Shear Works Co., Cleveland, Ohio. Calendar having a sheet for each week from November, 1918, to May, 1919. Each sheet contains illustrations of one of the machines built by the company and on the back of each sheet there are specifications making it possible to use the sheet in ordering standard punches and dies.

W. S. Rockwell Co., 50 Church St., New York City. Bulletin 36, illustrating and describing the Rockwell line of tilting reverberatory melting furnaces for non-ferrous metals, made in capacities ranging from 500 to 2000 pounds. Bulletin 37, illustrating bright annealing furnaces for annealing copper wire and similar products without oxidation.

Crescent Belt Fastener Co., 381 4th Ave., New York City. Booklet entitled "Gone Again," which contains a story about belt fasteners written in humorous vein in the style of a "movie" comedy. The booklet will be sent upon request addressed to the sales department, together with full technical and practical information on Crescent belt fasteners.

National X-Ray Reflector Co., 235 W. Jackson Blvd., Chicago, Ill. Booklet entitled, "X-Ray Flood Lighting," devoted to lighting problems and equipment. Three new "X-Ray" projectors are featured in this bulletin. Booklet "X-Ray Flood Lighting Projectors and Reflectors" describing equipment, accessories, and fittings required for the X-Ray indirect lighting systems.

Webster & Perks Tool Co., Springfield, Ohio, manufacturer of ball bearing and plain bearing grinding, buffing and polishing machinery, has issued a booklet containing a reprint of an article entitled "The Economical Use of Grinding Wheels," by W. T. Montague, which was presented at the Boston meeting of the Metals Division of the American Institute of Mining Engineers.

Arthur Knapp Engineering Corporation, 101 Park Ave., New York City. Catalogue of complete laboratory equipment for the inspection of screw threads, gages, taps, dies, hobs, cutters, and chasers. The catalogue illustrates and describes angle projection apparatus for examining screw threads, bevel protractor for measuring the angles of threads, lead testing machine, and pitch diameter measuring machine.

Jones & Lamson Machine Co., Springfield, Vt. 1918 catalogue of the Fay automatic lathe, a machine for the automatic turning of work held on centers. This catalogue is bound in cloth and contains 85 pages, 6 by 9 inches, illustrated with high-grade halftones and line illustrations. It contains a complete description of the Fay automatic lathe and its various parts, pointing out the features that make intensive production possible, and illustrates operations for which the machine is particularly adapted.

G. A. Gray Co., Cincinnati, Ohio. Catalogue of Gray constant- and variable-speed planers, made in two types, namely spur-geared and spiral-geared. The catalogue is profusely illustrated with views of planers of various sizes and detailed views of the mechanism. It contains a general description of the planers as well as tables giving dimensions of the different sizes. These planers can be furnished with or without motor drive. Special attention is called to the fact that all exposed gears are completely covered to safeguard the workmen.

American Society of Mechanical Engineers, 29 W. 39th St., New York City. Condensed catalogues of mechanical equipment with general classified directory and engineering data section. Eighth annual volume (1918). This volume contains 812 pages, 6 by 9 inches, and includes, in addition to the catalogue material, mechanical equipment directory, standardization work of the society, list of transaction papers, and engineering data. Four hundred and fifteen firms, including the majority of the leading manufacturers in their respective lines, are represented in this edition, which has been substantially increased in size and comprehensiveness.

Industrial Worcester. Circular published cooperatively by several Worcester manufacturers to advertise their products and the city in which they are located. The following manufacturers are represented: Boston Pressed Metal Co., manufacturer of special stampings from metal; Coes Wrench Co., manufacturer of the Coes knife-handle, key model, and steel-handle wrenches; Graton & Knight Mfg. Co., manufacturer of leather belting; Loring Coes & Co., manufacturer of all kinds of machine and planer knives; White & Bagley Co., manufacturer of "Oilzum Motro" oils and "Economy" cutting lubricant; and Wright Wire Co., manufacturer of "Excelsior" wire products.

Hess-Bright Mfg. Co., Philadelphia, Pa. Catalogue entitled "Hess-Bright Ball Bearings," containing first a history of the development of ball bearings and information relating to the use of Hess-Bright bearings in automobiles and airplanes. Another section of the catalogue is devoted to typical ball bearing applications, dealing with the application of ball bearings in machine tools, in flour and feed milling machinery, in woodworking machinery, and in electrical machinery. General information and list prices conclude the book, which covers 108 pages, 6 by 9 inches. The catalogue is substantially bound in a stiff board cover, and in view of the actual engineering information contained, in addition to the regular catalogue features, should be of value as a reference book for engineers and designers.

Chemical Catalogue Co., Inc., 1 Madison Ave., New York City. Third edition of a collected, condensed, and standardized catalogue of chemical engineering equipment and machinery, as well as heavy and light chemicals, dyestuffs, alloys, ores, oils, and raw materials for manufacturing industries. 836 pages, 9 by 12 inches. This book comprises a directory for the lines mentioned as well as a book of reference for chemical engineers, buyers, and others seeking information on chemical and metallurgical equipment, machinery, chemicals, and supplies. It is a collection of condensed catalogues and indexed data bound in one volume. The book is published annually under the supervision of a committee appointed by the American Institute of Chemical Engineers, the American Chemical Society, and the Society of Chemical Industry. In this edition a technical book department has been added, giving a list of technical and scientific books bearing on the chemical industry and related branches of engineering, arranged alphabetically under the author's name. The author, title of the book, publisher, and price is given as well as a synopsis of the contents. This department has been added as the result of repeated requests from users of the catalogue. Those desiring to obtain books can order directly from the Chemical Catalogue Co. and books will be sold at the publisher's price. A copy of the Chemical Engineering catalogue will be lent without charge for a period of one year to any chemical engineer, chief chemist, industrial plant superintendent, works manager, buyer, or head of a chemical department in a university or college. On the issuance of a new catalogue the old one will be recalled and the new one substituted. To others than those included in the above classifications, the charge is $5.

TRADE NOTES

Holton Tractor Co., 136 W. Maryland St., Indianapolis, Ind., announces that it is in the market for all kinds of machine tools and would be glad to receive machine tool catalogues.

William L. Procunier, manufacturer of "Double Gripp" safety tapping chucks, who was formerly located at 547-549 Washington Boulevard, Chicago, Ill., has moved to 14 S. Jefferson St.

Krasberg Engineering & Mfg. Corporation, 536 Lake Shore Drive, Chicago, Ill., has taken over the plant, properties, and business of the Krasberg Mfg. Co., and has assumed all its obligations and outstanding contracts and orders.

Detroit, Toledo, and Ironton Railway Co. is erecting an eight-stall engine house and machine shop, at Napoleon, Ohio. The structure alone will cost $80,000 without equipment and is being erected by the Crowell-Lundoff-Little Co., Cleveland, Ohio.

Newman Mfg. Co., Cincinnati, Ohio, is manufacturing an "Honor Roll" tablet consisting of a grooved back board covered with cloth and white enameled finished letters with prongs, which fit into the grooves, for posting the names of the men who have served under the flag, as a permanent record of appreciation.

W. K. Millholland Machine Co., Indianapolis, Ind., maker of screw machines and turret lathes, has moved into the company's permanent location at W. 23rd St. and Belt Line Railroad, Indianapolis, where a shop having a floor space of 20,000 square feet is now available for handling the screw machine and turret lathe business.

Walcott Lathe Co., 115 Calhoun St., Jackson, Mich., has recently completed an addition to its plant, which is a modern steel and brick building, 180 by 275 feet in size. This building will be used exclusively for the manufacture of the Walcott 26-, 29-, 33-, and 36-inch lathes. Entirely new equipment has been installed for this purpose.

Wetmore Mechanical Laboratory, 605 Enterprise Bldg., Milwaukee, Wis., maker of hobs, reamers, threading tools, gages, etc., has added a commercial heat-treating department to the facilities of its plant, and besides handling its own work it is now prepared to take care of outside orders. The heat-treatment of high-speed steel cutting tools is the specialty of the new department.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., has opened an office in the New Lexington Bldg., Baltimore, Md., in order to take care of the rapidly increasing southern business and to give closer service to users of Shepard apparatus in that territory. The office will be in charge of Norman P. Farrar, who for a number of years has been district manager of the Philadelphia territory.

Cleveland Galvanizing Works Co., Cleveland, Ohio, has changed its name to the **Chain Products Co.**, in order to identify the company more closely with its product, as its business in weldless chain has outstripped its Custom Galvanizing Department. There are no changes in the management, personnel, or policy of the company and the Custom Galvanizing Department will be carried on exactly the same as before.

National Electric & Welding Co., 90 West St., New York City, has been appointed New York sales agent for the C. & C. Electric & Mfg. Co., Garwood, N. J., and has also been appointed Eastern sales agent for the Wesche Electric Co. of Cincinnati. The former personnel of the New York sales office of the C. & C. Electric & Mfg. Co. is now handling both C. & C. and Wesche machinery, the lines having been extended to include alternating-current and direct-current equipment, arc welders, etc.

Cisco Machine Tool Co., Cincinnati, Ohio, manufacturer of 14- to 24-inch lathes, has moved into its new building at Elmore St. and C. H. & D. Railroad. This building is a two-story structure, 64 by 220 feet, which is now fully equipped with machinery for the manufacture of lathes of the sizes mentioned. About $100,000 worth of new machinery and equipment has been installed and, in addition to the lathes already manufactured, the company announces that it is bringing out a new geared-head lathe.

Austin Co., Cleveland, Ohio, industrial engineers and builders, announce that the company is now prepared to duplicate all of its standard steel factory building designs in wood construction. This departure has been made necessary by the imperative need for conserving steel for direct war purposes, the Government having practically put a ban on steel construction for the time being. The Austin Co. has published a booklet showing standard factory buildings in wood, indicating how similar constructions to those previously furnished in steel may be applied to various classes of buildings.